THE RELATIONSHIP AMONG HEMISPHERIC BRAIN PREFERENCE, GENDER, AND ACADEMIC ACHIEVEMENT OF FOURTH AND SEVENTH GRADE PUPILS

By

JUANITA CUMMINGS FOUNTAIN

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1986

TO MY FATHER,

MACK C. CUMMINGS

AND

THE MEMORY OF MY MOTHER

IDA M. CUMMINGS
(1924-1951)

ACKNOWLEDGEMENTS

The help of my committee members, my colleagues, my friends, and my family have all made the completion of this project possible.

Special appreciation is extended to the members of my supervisory committee: Dr. Henry T. Fillmer my chairman, for his patience with and enthusiasm for the project, his prompt and insightful feedback, and above all his faith that I would complete the degree; Dr. Elois Scott, for her ideas on measurement and data analysis, her assistance in critiquing the statistical sections of the study, and her tolerance of my many questions; Dr. Edward Turner, for his patience and calm and for his expert help as a committee member; Dr. Joseph Shea, for his perceptive questions and helpful suggestions during the course of the study; and Dr. Simon Johnson, for his constant encouragement and support.

Sincere appreciation is extended to the Alachua County School Board for permission to conduct the study and to the staff in the county testing office for their helpfulness. I am also grateful to the school administrators and the children who enthusiastically participated in the study.

Special thanks are extended to my colleagues and friends: Everton Rowe, a fellow doctoral student in statistics, for his assistance in planning the computer program; Drs. Betty Stewart, Eleanor Schenck, Sheila Smalley, and Shelton Davis, personal friends, and former fellow graduate students, for supporting and encouraging me, and for assuming that I would finish.

And finally, to my family, I wish to express my deepest appreciation, for the many sacrifices and inconveniences they have endured as a result of this project. I am eternally grateful to my son, Ivan, for allowing his mom to spend many long hours in "semi-solitude." A special and loving thank you is extended to my husband, Charles, for his expertise and perseverance in typing this manuscript and for maintaining his usual calm manner in the midst of my frantic efforts to meet the deadline dates.

TABLE OF CONTENTS

LIST OF TABLES

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

THE RELATIONSHIP AMONG HEMISPHERIC BRAIN PREFERENCE,
GENDER, AND ACADEMIC ACHIEVEMENT OF FOURTH
AND SEVENTH GRADE PUPILS

By

Juanita Cummings Fountain

December 1986

Chairman: Dr. Henry T. Fillmer
Major Department: Instruction and Curriculum

The purpose of this study was to assess students' academic performance in relation to their preferred cerebral hemispheric mode. The sample included 131 white average and above-average ability fourth and seventh grade students identified by brain preference according to the "Your Style of Learning and Thinking" Inventory and grouped by sex and grade level. The results of the Otis-Lennon School Ability Test and the Reading Instructional Level from the Metropolitan Achievement Test were used to identify students of average and above-average ability.

The primary data analysis techniques utilized were chi square and ANOVA. The dependent variables were the measures of achievement on three subtests (reading, mathematics, and language) and the basic score of the Metropolitan Achievement Test administered during the 1985-86 school year. The independent variables were sex (male and female) and hemispheric brain preference (left, right, and integrated). Separate analyses were run for grade four and grade seven.

The results of the chi square analyses revealed the following: (1) Fourth and seventh grade pupils showed no difference in hemispheric brain preferences. (2) Males and females showed a significant difference ($p < .05$) in hemispheric brain preferences (more females had integrated-hemispheric preferences).

The results of the ANOVA showed the following: (1) Fourth grade integrated-hemisphere preference students had higher scores in reading, mathematics, language, and basic score than either the left- or right-hemisphere preference students ($p < .05$). (2) Seventh grade students did not show a difference in hemispheric brain preference. (3) A sex by hemispheric brain preference interaction ($p < .05$) was found for seventh grade pupils in mathematics and basic score only (seventh grade integrated males achieved at higher levels than integrated females). (4) Fourth grade pupils did not show an interactive effect between hemispheric brain preferences and sex.

The implications of this study suggest that it is desirable that educators become knowledgeable about the effects of various hemispheric preferences on academic performance. Further, a knowledge of the learning and thinking style preferred by students, with regard to hemispheric preferences, would enable educators to prepare lesson plans that include approaches to help students develop a more integrated style of learning if they have a dominant left- or right-preference.

CHAPTER I

INTRODUCTION

Presently, there is a growing body of research on brain preference, or hemisphericity and its role in school atmospheres. A major reason for interest in the role of hemispheric brain preferences in school learning is that brain preferences offer data relevant to understanding the processes of human learning and, therefore, may be employed to improve teaching methods. Further, such research might provide some insight into possible explanations for the growing numbers of children who are underachieving and not succeeding in today's schools.

While there is still a great deal of uncertainty on whether cerebral specialization depends on the type of task (verbal or spatial) or the manner in which the task is processed (sequential or simultaneous), recent writers and researchers on the brain do agree on several major points about the hemispheres. The right-hemisphere specializes in processing spatial, visual, movement, and touch stimuli in terms of simultaneous holistic patterns and relationships, while the left-brain specializes in processing linguistic stimuli, in terms of time, details, and sequence (Bradshaw & Nettleton, 1981; Kolb & Whishaw, 1980; Springer & Deutsch, 1985). Learning is generally accomplished through the left-hemisphere, the right-hemisphere, or the successful integration of both as a matter of individual differences. However, if neither side of the brain is allowed to fully develop, then, the potential of either hemisphere will remain unchallenged. According to Vitale (1982), "this

potential is achieved when both hemispheres are working to their capacity and the information from both is integrated into a whole" (p. 107). The implication, then, is that neither hemisphere is superior to the other, but rather, both sides of the brain are required for integrated thinking.

The Problem

Problem Statement and Hypotheses

There is an explicit need to assess the relationship between brain preferences and academic failure or success. Thus, the primary purpose of this study was the objective assessment of students' academic performance in relation to their preferred cerebral hemispheric mode. Further, the demonstration of reliable differences and relationships between student's brain preference and academic achievement could have implications for helping teachers recognize the importance of left, right, and integrated-hemispheric thought in education for specific and general curriculum development.

The questions that formed the basis for this study were as follows: (1) To what extent is academic performance affected by hemispheric brain preference as measured by a standardized test? and (2) To what extent are brain preferences affected by sex and/or grade level?

This study tested the following hypotheses concerning the relationship between brain preference and sex, for each grade level (four and seven) in relationship to the research subject's performance on a standardized test.

HO_1: There is no significant difference ($p < .05$) in hemispheric brain preference (left, right, and integrated) between fourth and seventh grade pupils.

HO_2: There is no significant difference ($p < .05$) in hemispheric brain preference (left, right, and integrated) between males and females.

HO_3: There are no significant differences ($p < .05$) in mean achievement among pupils with left-, right-, and integrated-hemispheric preferences by grade level as measured by the Metropolitan Achievement Test (reading, mathematics, language, and basic score).

HO_4: There are no significant differences ($p < .05$) in mean achievement among the hemispheric brain preference categories and sex as measured by the Metropolitan Achievement Test (reading, mathematics, language, and basic score).

Delimitations and Limitations

The study was restricted to a total of 131 average and above-average ability white pupils who were enrolled in the fourth and seventh grades in four public schools in Alachua County, Florida. The results of this study can only be generalized to similar populations.

While brain preference, gender, and grade level could be influences on students' level of achievement, it is recognized that other variables such as family influences, student motivation, and factors related to teachers' learning and teaching style could also influence academic achievement. Only those variables listed above were studied in this investigation.

Several factors in this study could limit its generalizability. The students who were included in this study comprised a volunteer population and may not be a representative sample of the pupils in the general population. Students with I.Q. scores below 90 were omitted from this study since it was assumed that they would normally have some difficulty in reading and understanding the self-report inventory used in this study.

Justification of the Study

There is general agreement among educators that our educational system has stressed the more measurable left-hemispheric mathematical and verbal skills which are referred to as "the basics" and has, ignored the development of "right-brained" intuitive thinking (Galin & Ornstein, 1973; Grady, 1983; Sinatra & Stahl-Gemake, 1983; Sperry, 1974). This overemphasis of left-hemispheric experiences probably comes from the public's demand for more attention to the basic skills (reading, writing, and mathematics).

Research has, however, shown that the two halves of the brain are specialized for different cognitive functions, but the constant use of one hemisphere or the other can cause humans to rely too heavily on either left- or right-brain thinking (Nebes, 1977).

If an elementary education program focuses mainly on left-hemisphere skills at the expense of right-hemisphere skills, then students who are more right-hemisphere dominant will not achieve success as often as their peers. As a result, the right-hemisphere dominant student will become frustrated and could possibly reject the entire educational experience. Along these same lines, Webb (1982) suggested that a large number of students failing school displayed behaviors associated with right-brain learning.

Rosenthal and Jacobson (1968) have shown that teachers unintentionally convey their performance expectations to students. Teachers who are unaware of the value of integrated thinking skills and believe that left-hemisphere skills are more important than right-hemisphere skills may respond by not allowing students the opportunity to use and develop right-hemisphere thinking in the academic subjects (mathematics, reading, and language).

Bogen (1975), Grow and Johnson (1983), Walker (1985), Wittrock (1977), and others have discussed the implications of recent brain research on cerebral hemisphere functions for improving methods of teaching. It is suggested that educators should become familiar with the recent research on brain hemisphericity because it would make them aware that there is an interactive effect of right-hemisphere and left-hemisphere strategies in nearly all cognitive processing. Therefore, it is essential that right-hemisphere and integrated activities be stressed equally in school curriculums. This approach to teaching would allow all students to benefit from a "balanced" curriculum, even those that are handicapped in the schools because of a right-hemisphere preference (Fox, 1979). It is important that educators learn to recognize the right-hemisphere preference student as another source of equally essential creative, artistic, and intellectual talent.

Sylwester (1981) claimed that few preservice programs introduce relevant brain research and implications to their students as a regular part of course requirements. Therefore, it is essential that curriculum policy planners and administrators learn to translate the relevant data on brain hemispheres into meaningful classroom experiences and procedures for both preservice and classroom teachers.

If educators know something about the educational preferences of children and the kinds of experiences which could have the greatest impact on them, then experiences could be designed for individuals to achieve at optimal efficiency. Thus, knowledge of students' brain preferences can impact on teaching and learning by allowing teachers to work more effectively with students. There is a need, then, for educators to learn to diagnosis the learning and thinking styles of students

through unobtrusive measures. Torrance and his associates (1976, 1977) have formulated just such a measure, a paper-pencil self-report inventory which assesses an individual's lateral preference for thinking and learning.

A great deal of the literature using the Your Style of Learning and Thinking (SOLAT) instruments has focused on adult concerns, the gifted population, and the disable learner. However, the classroom teacher faces the problem each day of reaching all of the students, especially those that are labeled "average." These students are often overlooked and unchallenged; therefore, many of them may be having trouble adjusting to the linear, sequential, and analytic functions (left-hemisphere) that some school curriculums employ.

If teachers are aware of their student's learning style and are convinced of the worth of instruments such as the SOLAT, which sheds light on individual problem-solving and thinking styles, then they will be in a better position to maximize the learning potential of all students.

Gray (1980) has suggested that educational systems are producing young people "who can calculate but cannot conceptualize, who can master formulas but who do not know how to apply them" (p. 131). Eisner (1981) has asserted that sensory deprivation is a major cause of illiteracy in our nation's schools. He declared that children who have not learned to visually and mentally explore the forms of nature, art, and science will simply not have had the kinds of experiences that would enable them to write or speak effectively.

Assumptions

The major assumption of this study was that all students selected could provide sufficient responses to the test used to identify students

by brain preference. Further, the "Your Style of Learning and Thinking (SOLAT)" scores for each learning category reflected hemispheric processing which in turn reflected learning style.

A second assumption of this study was that the subgroups of fourth grade students have had similar opportunities regarding curriculum content as well as similar instructional strategies. Likewise, the subgroups of seventh grade students in the study were also assumed to have had similar elementary school experiences and have been exposed to similar instructional strategies at the middle school level.

The third assumption was that all students included in the analysis of data would have scores on all tests: The Children's Form of Your Style of Learning and Thinking, the Metropolitan Achievement Test, and the Otis-Lennon School Ability Test.

Definition of Terms

Many of the terms used in this study are not familiar to educators and, therefore, may not be a part of their knowledge-base. In an attempt to help the readers of this study better understand the terminology used in examining brain research, the following terms are defined. A few more pertinent terms are defined in Chapter II, the review of the literature.

Commissurotomy. An operation in which the corpus callosum is surgically severed.

Corpus callosum. The bundle of nerve fibers which "bridge" the two cerebral hemispheres.

Hemispheric dominance. An obsolete view of the relationship between the two hemispheres of the brain. The left-hemisphere is described as the director of speech and other higher functions, while

the right or "minor" hemisphere is without special functions and subordinate to control by the "dominant" left.

Hemispheric integration or cooperation. The participation of both hemispheres in processing information.

Hemispheric specialization. The two hemispheres of the human brain are specialized for different modes or styles of information processing.

Holistic. In terms of cognitive functions, the simultaneous processing of a configuration of information, rather than the sequential processing of its separate parts.

Lateralization. The limiting of stimuli to one hemisphere.

Lobotomy. The Surgical division of a lobe, usually the frontal lobe, from other parts of the brain; disconnecting cerebral nerve tracts.

Organization of the Remainder of the Study

In Chapter II, a review is provided of the related literature regarding brain laterality and its implications within the scope of this study. Chapter III presents the design, instrumentation, procedures, and data analysis for the study. The population is also described. Chapter IV contains the data analysis and summary tables. A discussion of the results, conclusions, and recommendations for further related research is presented in Chapter V.

CHAPTER II

REVIEW OF THE LITERATURE

According to Sylwester (1982), the average human brain weighs about three pounds, which is approximately 2% of the body weight of an adult, and uses nearly one-fifth of all the body's energy, roughly 1½ pints of blood each per waking minute. The brain is divided into halves (called hemispheres) which are almost physically symmetrical. The cerebral cortex forms the upper surface of the brain and is the area where thinking processes take place. The two halves of the cerebral cortex are joined together by the corpus callosum which allows information to travel through its trillions of connections at a speed equivalent to 250 miles an hour (p. 64).

Much of what is known today about the brain's function is derived from clinical studies of the behavioral and cultural deficits in individuals with unilateral lesions, hemispherectomy, temporal hemispheric deactivation, and commissurotomy (surgical disconnection of the cerebral hemispheres).

Cerebral Dominance

The original concept of cerebral dominance was based on the idea that one hemisphere, usually the left, dominated the control of language and behavior. It gained support from early findings with split-brain patients showing that the left-hemisphere assumed control of responding in situations where there were simultaneous and different inputs to the two hemispheres. The evidence that our left-brain is specialized for language led many to call this the "dominant" hemisphere or the "major"

hemisphere, implying that the right side of the brain was subordinate, minor, and inferior (Nebes, 1977).

Brain Lateralization for Language

Two neurologists, Broca and Wernicke, are mainly responsible for drawing attention to the left-hemisphere's dominance in language functions (reviewed in Gazzaniga & Ledoux, 1978; Gilinsky, 1984). Broca reported in 1861, that autopsies on all of his asphasic patients showed lesions in a special region in the posterior portion of the frontal lobe on the left half of the brain. This was a major piece of evidence that speech was localized mainly in the left-hemisphere. This special region on the left-hemisphere became known as "Broca's area" and the inability to speak--but with comprehension unimpaired--was called "Broca's aphasia." Similar damage to the right-hemisphere did not seem to disturb language functions. Broca's research dealt mainly with language expression; his patient could understand, but could not speak.

Around 1876, Wernicke, described a new type of aphasia, a disorder of language reception. His patient could speak, but could not comprehend. Wernicke's aphasia was located in the left-hemisphere, in the rear of the temporal lobe, near the sensory projection areas for sight and hearing.

Early Clinical Studies

Early split-brain research has unveiled significant differences in left and right cognitive modes. Interest in the different thinking styles associated with the two cerebral hemispheres has roots which date back over a century. As early as the 1860s and 1870s, brain specialists, Jules Dejerine of France and Huto Liepmann of Germany studied patients who had suffered damage to the commissures (corpus callosum) that connect the two sides of the brain (Gilinsky, 1984). The damage in

these patients had been caused by strokes. It was found that damage to certain patients' left cerebral hemispheres resulted in a loss of speech and reasoning abilities, while damage to other patients' right cerebral hemispheres was associated with losses of spatial ability (Ettlinger, Warrington, & Zangwill, 1957).

In contrast to patients with unilateral brain damage, commissurotomy patients possess two relatively normal hemispheres whose functions, presumably, can be separately tested. It was discovered during the 1940s that surgical division of the corpus callosum was an extremely effective procedure for reducing the frequency and severity of epileptic seizures in patients for whom other therapies had failed (Van Wagenen & Herren, 1940). Thus, Van Wagenen was one of the first to perform split-brain operations on humans (the operations were unsuccessful) in the early 1940s.

Akelaitis (1941, 1944) studied Van Wagenen's 26 commissurotomy patients hoping to find that they possess two normal hemispheres whose functions could be tested separately. The results were disappointing, the tests did not show any significant differences between commissurotomy patients and normal subjects that could be associated with the disconnection of the corpus callosum. Further, the surgery was not uniformly effective for seizure control.

Springer and Deutsch (1985) attributes the variability of the surgical success in these patients to the following causes: "(1) individual differences in the nature of the epilepsy in the patients and (2) variations in the actual surgical procedures used with each patient" (p. 27).

In the early 1950s, Myers and Sperry (1953), and Sperry (1961) reported on their research of the visual pathways of the cat, which

later proved beneficial to other investigators. They developed a method of splitting the optic chiasm. This procedure allowed visual information presented to one eye and hemisphere to be projected only to that hemisphere without visual crossover. However, they did find some transfer between the two hemispheres. Subsequent split-brain experiments were perfected and performed on monkeys and finally on humans.

The first "complete" commissurotomies were done by Bogen and Vogel (1962), Bogen and Vogel (1963), and Bogen, Sperry, and Vogel (1969) in an effort to relieve the effects of intractable epilepsy. After careful review of akelaitis' series of studies, they reasoned that the earlier split-brain procedures (with humans) had failed because the hemispheres had never been completely disconnected. Their work was so successful that some of their patients were able to return to nearly normal lives.

Hemispheric Specialization

Evidence in support of specialized functions comes from split-brain research and from research on normal individuals. Thompson, Berger and Berry (1980) have summarized the information gained from clinical observation of split-brain patients. They stated that "each cerebral hemisphere seems to be specialized for certain cognitive or perceptual functions. When this discovery was first made, cerebral dominance in language and verbal functions was ascribed to the left-hemisphere seemed incapable of language. However, rigorous testing of such patients indicated that "hemispheric specialization" may be a better term, since language functions appear to be present on both sides of the brain" (p. 31). The difference between the hemispheres according to Grady and Luecke (1978-79) is the way that each receives and processes stimuli.

The Left Hemisphere

The right side of the body is controlled by the left-hemisphere which specializes in logical-analytical thinking and verbalization. These include talking, reading, writing, mathematical calculation, and many of the functions that involve linguistic and numerical processes (Sperry, 1974). This kind of information is processed linearly, sequentially, and logically. In terms of mind function, this means that the left cerebral hemisphere tends to mediate imputs in a reductive, or "sorting out" way, processing the variables systematically in order to find the final "best answer" or solution. This is the blueprint for the rational linear, cognitive domain. Thus, the left-hemisphere influences the basic skills necessary for school achievement such as reading, arithmetic, writing, and oral language processing.

The Right Hemisphere

The other side of the brain, the right-hemisphere, specializes in spatial perception, holistic understanding, perceptual insight, tactile sensation, musical ability, emotions, visualization ability, and some intuitive ability (Bogen, 1975; Gazzaniga, 1975; Samples, 1977; Sperry, 1974). This kind of information is processed nonlinearly and subjectively. In terms of the mind function, the right-hemisphere functions on relationships and multiple-images, experiences, emotions and a wide assortment of mental operations in a way that encourages invention. Thus, this hemisphere is associated with skills useful to the "arts" such as the production of painting, music, and sculpture.

The kind of knowledge identified with the right-hemisphere has been called appositional (Bogen, 1977). Propositional is the term neurologists have used to describe the left-hemisphere's dominance for speaking, writing, and calculation. The meaning of the abbreviation

"appositional", is "according to the rules of information processing which we infer to be typical of the right-hemisphere of well-lateralized right-handers" (Bogen, 1977, p. 138).

Dreaming is another area associated with the right-brain. One reason for this is that dreams are usually highly image ridden and creative as opposed to analytical and verbal.

Evidence Supporting Hemispheric Specialization

The vast majority of data available today on hemispheric specialization come from two main sources: clinical and normative studies (anatomical, neurophysical, and behavioral).

Clinical Studies

Roger Sperry and his associates (1969) further improved the commissurotomy operation (surgically severing the corpus callosum) which was designed for successfully retarding severe epileptic seizures in humans. This testing procedure would allow information to be fed into one or the other hemisphere of these "split-brain" patients while allowing the responses of either hemisphere to be independently observed. The successful severing of the corpus callosum in these epileptic patients was done in the hope of limiting severe seizures to one side of the body. It was surmised that seizures developed in one cerebral hemisphere excited the other via the corpus callosum so that the seizures rapidly became generalized. The operations proved successful in the elimination of severe epileptic seizures, thus, allowing the patients to return to fairly normal lives with each hemisphere functioning independently of the other.

Levy-Agresti and Sperry (1968) were the first researchers using split-brain patients to suggest that the hemispheres differed in their modes of thinking and information processing strategies, not merely in

executive capacities. Bogen (1969) also reached the same conclusion as Levy-Agresti and Sperry. He said, "In the human, where propositional thought is typically lateralized to one hemisphere, the other hemisphere evidently specializes in a different mode of thought, which may be called appositional" (pp.157-158). The conclusions reached by Levy-Agresti and Sperry (1968) and Bogen (1969) have gained widespread acceptance and, therefore, since 1968, split-brain research has focused on defining the thought processes that characterize the differential specializations of the two sides of the brain.

Normative Studies

This section contains studies of persons whose thinking processes are not complicated by possible influences from either brain damage or epilepsy. The investigation of cerebral asymmetries in normal subjects has been carried out in several ways. One of the oldest and most widely used procedures takes advantage of the natural split in human visual pathways. This split neatly divides the visual world into two fields, each of which projects into one hemisphere (tachistoscopic image technique). By flashing material very briefly to the left or right of the point where a subject is fixating, investigators are able to lateralize inputs--that is, to present them to one hemisphere only. Because of the connections between the hemispheres, this one-sided presentation lasts only a fraction of a second, but it appears to be sufficient to allow investigators to compare the abilities of one hemisphere to those of the other.

Similarly, it has been discovered that simultaneously presenting different auditory information to each ear leads to the initial lateralization of auditory stimuli. Information presented to the left ear appears to project first to the right-hemisphere, and information

presented to the right ear is lateralized to the left-hemisphere. This procedure, known as dichotic listening, has allowed investigators to study differences and similarities in the way the two hemispheres handle speech as well as other types of auditory information.

A rather speculative approach (conjugate lateral eye movements) to the study of asymmetry in normal subjects has involved the careful observation of overt behavior while subjects engage in different tasks. For instance, a person's eye movements to one side or the other have been used to show which hemisphere is more active when the subject is solving a problem, playing a mental game, or responding to questions.

Evidence for hemispheric specialization also derives from brain-activity data secured by means of electroencephalographic (EEG) techniques. When these procedures are employed, the alpha band usually provides a base line for brain activity recorded from both hemispheres while subjects are actively engaged in a cognitive task. The presence of alpha-level wave lengths implies that the brain is not engaged in complex-information processing activities.

Anatomical studies

Anatomical evidence, the study of the morphological variations in the brain, can be seen in structural intrahemispheric and inter-hemispheric brain asymmetries. Studies have been done on adults, children, infants, and even fetal brains.

Geschwind and Levitsky (1968) measured 100 human brains, using only a camera and ruler. They were mainly interested in the planum temporale, a posterior region on the surface of the temporal lobe that forms part of Wernicke's area (speech zone). This region was found to be larger on the left side than on the right. According to Geschwind

and Levitsky's data the left planum was larger in 65% of the brains, the right planum was larger in 11% of the brains, and the rest were approximately equal in size.

Witelson and Pallie (1973) examined 14 infant brains and found that the planum temporale in the left-hemisphere of the female brains was more developed than the left side of the male brains. Wada, Clarke, and Hamm (1975) found different results when they examined a hundred adult brains. The right and left temporal planes were larger in males than in females. LeMay and Culebras (1972) studied the brain of human fetuses and found the left parietal operculum was larger than its counterpart in the right-hemisphere.

Neurophysical studies

Neurophysiological evidence includes measures of neurophysiological activity of the cortex for various stimuli and cognitive tasks such as electroencephalographic recordings, evoked potentials, and the patterns of blood irrigation and metabolism. Galin and Ornstein (1972) were two of the first investigators to study the asymmetries of the brain in detail and to relate them to the nature of the task performed by the subject while the EEG (electrodes placed on both sides of the head) was being recorded. Previously, EEG recordings were made by placing electrodes at different points on the top of the head or only on one side of the head. The two sides of the body were assumed to generate identical sets of data.

Electroencephalographic measures of asymmetry are useful to many investigators because they do not rely on an overt response from the subject and they can be used to study brain asymmetries in a variety of subjects such as infants, aphasic patients, and other subjects from whom it might be difficult to obtain such responses. Further, EEG is a

continuous measure over time and can be used to study ongoing activity in the brain while the subjects performs long, complex tasks.

Butler and Glass (1974) studied subjects while engaged in mental arithmetic. The recorded brain-wave activity (above the level of alpha) was higher in the left-hemisphere than in the right-hemisphere, which indicated that the left-brain was activated for this kind of task. Galin and Ellis (1975) observed subjects who were working on a verbal task (written recall of a text) and found that they produced more brain-wave activity in the left-hemisphere than in the right. They also noted that the brain-wave activity pattern was reversed for individuals who were involved in a spatial task (reproduction of geometric designs from memory).

Behavioral studies

Behavioral evidence in normal subjects can be obtained by using experimental techniques which allow information to be presented asymmetrically to each hemisphere. There are several kinds of perceptual asymmetry tests, specifically, visual information (e.g., lateral tachistoscopic studies and chimeric stimuli), auditory information (e.g., dichotic studies), and somesthetic information (e.g., tactile and dichaptic studies); psychophysical differential scales; and tests of motoric asymmetry (Gilinsky, 1984).

Tachistoscopic image studies. This technique allows visual data (words or nonverbal stimuli) to be flashed at variable speeds to either the right or left visual field of the eye. Data transmitted to the right visual field are processed in the left-hemisphere and data flashed to the left visual field are processed in the right-hemisphere. Several recent studies support the theory that verbal stimuli are processed more effectively in the left-hemisphere, whereas spatial stimuli are processed more effectively in the right-hemisphere.

White and Silver (1975) studied subjects who were presented verbal stimuli (CVC nonsense syllables) and visual stimuli (grid patterns) which was flashed to the left visual field, the right visual field, and to both fields at the same time. Processing accuracy (number of correct identifications) was highest when the left-hemisphere received verbal material and the right-hemisphere received spatial material.

In another study using tachistoscopic techniques, verbal material (words) and nonverbal material (ink blot shapes and faces) was presented to subjects' right and left visual fields (Hines, 1975). He found that verbal information was processed more accurately when presented to the right visual field which was automatically transmitted to the left-hemisphere field.

Dichotic listening. A technique developed by Broadbent (1954), "dichotic listening," has been widely used in studying normal subjects. In this procedure sound patterns are transmitted to the right and left-hemispheres and subjects are asked to recall the material presented. Semantic characteristics of the stimuli influence how they are processed in a given cerebral hemisphere. Thus, the dichotic listening technique can be used to determine hemispheric superiority for different kinds of acoustic stimuli.

Dichotic listening is built on the theory that auditory crossover between ear and hemisphere occurs in much the same way as the visual crossover between eye and hemisphere. This technique allows auditory stimuli to be presented to the left ear and transmitted to the right-hemisphere, and information presented to the right ear to be transmitted to the left-hemisphere.

Kimura (1961) used the dichotic listening procedure to compare the performances of brain-damaged subjects and normal subjects in a task

involving an overload of information. She found that patients with damage to the left temporal lobe did more poorly than patients with damage to the right temporal lobe; but regardless of where the damage was located, subjects typically reported the information presented to the right ear (left-hemisphere) more accurately. This right ear advantage was also found in normal individuals.

The basic finding was that the ears performed asymmetrically. This is based on the fact that each ear sends information from all its receptors to both hemispheres. This complete information about a stimulus presented to the right ear is represented initially in both hemispheres, and vice versa. Even if speech stimuli could be processed in only one hemisphere, one would not expect to see any evidence of the asymmetry because each ear has direct access to both hemispheres.

Kimura (1963) used the dichotic listening technique to study the development of language lateralization in normal children (ages 4 to 9). All groups showed a right-ear superiority for speech except the girls in the 7- to 9-year-old group. These findings lead Kimura to hypothesize that lateralization does not increase beyond age five.

Conjugate lateral eye movement studies. Experiments using conjugate lateral eye movements (a shift of both eyes to the right or left during problem solving) appear to indicate which hemisphere of the brain is relatively more dormant. Clinical observation of conjugate lateral eye movements was first reported by Day (1964). In the course of his practice, he noticed that his patients tended to look to the left or to the right when answering questions. This behavior led him to suggest that personality and sex differences might be connected to lateral eye movement. He found that when parts of the left-hemisphere were

stimulated, the eyes would move to the right and when parts of the right-hemisphere were stimulated, the eyes would shift to the left. He described the typical left-mover as a female with a tendency to focus attention on internal subjective experiences, while the right-mover tended to be male.

Studies using Day's hypothesis have produced a variety of results. Kinsbourne (1972) was one of the researchers who later explored lateral eye movements LEMs as an index of hemispheric activity. His approach focused on the type of question used to elicit eye movements to the right or left. It was proposed that subjects would move their eyes to the right when asked a question that required verbal analysis, whereas, they would move their eyes to the left when asked questions involving the analysis of spatial relations. Kinsbourne's findings supported the tendency to look left when the right-hemisphere was activated and vice versa, however, a study by Ehrlichman, Weiner, and Baker (1974) did not.

Bakan, using Day's approach, further proposed that eye movements are related to hemispheric asymmetry. His (1969) study focused on the relationship between lateral eye movement and hynotic-susceptibility. He found that left-movers tend to have the highest hypnotic-susceptibility scores, majored in the humanties, scored higher on the verbal part of the SAT than the math part, and obtained high image clarity scores. Right-movers, on the other hand, have shown contrasting results.

Bakan's hypothesis was based on the well-established fact that eye movements to one side are controlled by centers in the frontal lobe of the opposite hemisphere. He suggested that cognitive activity occurring primarily in one hemisphere would trigger eye movements to the opposite

side, so that eye movements could be viewed as an index of the relative activity of the two hemispheres in an individual. Accordingly, left-lookers, or persons who typically make eye movements to the left, are those for whom the right-hemisphere predominates. Right-lookers are persons who have greater left-hemisphere involvement in overall functioning.

Schwartz and his colleagues (1975) have also looked at lateral eye movements in response to emotional questions. In addition to verbal and spatial questions requiring verbal analysis and spatial analysis, verbal emotional questions and spatial emotional questions were studied. Results showed that verbal questions overall produced more right LEMs than did spatial questions. Emotional questions overall produced more left LEMs. These findings have been taken as support for greater right-hemisphere involvement in the processing of emotional information.

Some studies have shown that the direction of eye gaze depends on the type of question posed to the subject. Gur, Gur, and Harris (1975) have shown that many right-lookers and left-lookers or consistent in their direction of gaze. They reasoned that the direction of eye gaze would depend on the kind of question (verbal or spatial) presented to the subject and the position of the experimenter (facing the subject or seated behind the subject) during question delivery. They suggested that the experimenter-present condition was more anxiety provoking and would cause the subject to respond inappropriately for the kind of question asked.

In order to test these concepts, an identical set of questions were used to compare the direction of the eye movements when an experimenter sat in front of the subject and when the experimenter was not in sight. The results showed that when the subject was facing the experimenter,

they looked in either direction regardless of the question. They also found that when the experimenter was not in view, the eye movements depended on the kind of question asked by the experimenter.

Other researchers have suggested that conjugate lateral eye movements are affected by such variables as intelligence (McCallum & Glynn, 1979) and field independence-dependence (Ehrlichman, 1977).

Age Related Factors in Brain Development

Plasticity

There is extensive documentation in the literature (Basser, 1962; Lenneberg, 1967; Zangwill, 1960), that the brain can reorganize itself. According to Grady (1984) "the brain has what is called plasticity. Although it does not regenerate new brain cells, it can form new connections among existing neurons. This organization of new connections takes place at all ages, but it is greatest in children up to the age of twelve, when it levels off. The brain is so plastic in the young that children who lose up to one-half of the brain can grow up to have normal intelligence" (p. 7).

Much of the supporting data on plasticity is derived from hemispherectomy operations, which were performed to alleviate the symptoms of infantile hemiplegia or to destroy life-threatening tumors. Basser (1962), Carlson et al. (1968), McFie (1961), and White (1961) found during post-operative examinations of these patients that following an early left-hemispherectomy for the treatment of infantile hemiplegia the right-hemisphere could take over the linguistic functioning that would normally be performed by the left-hemisphere.

Witelson (1976, 1977) has shown that the female right-brain has greater plasticity and over a longer period of time than the male brain.

Also, when the left-hemisphere of females is damaged, language functions are taken over by the right-hemisphere.

Progressive Lateralization Theory

The concept of progressive lateralization was mainly exposued by Lenneberg (1967) who theorized that the infant brain is undifferentiated at birth with both hemispheres possessing the potential for language. He further proposed that lateralization would increase with age, that is, the processing of linguistic information would be attributed to the left-hemisphere, while the processing of nonverbal information would be processed mainly by the right-hemisphere. There is some disagreement, however, over the age at which lateralization ends. In a reexamination of Lenneberg's data, Krashen (1973) found that in all the subjects with right-hemisphere aphasia, the damage was sustained before the age of 5. Thus, Krashen decided that lateralization was complete by that age. Brown and Jaffee (1975), on the other hand, purport that lateralization does not stop in the early years or puberty but rather continues on into old age. More recently, evidence has been mounting against the idea of progressive lateralization.

In looking at the physical structure of the brain Witelson and Pallie (1973) found that the human infant is born with, or develops soon after birth, a larger area in the left-hemisphere in a region (planum temporale) known to be significant in language development.

Segalowitz and Chapman (1980) observed neonates in their 26th gestational week and found evidence of cerebral asymmetry for speech. The infants were exposed to speech, orchestral music, and absence of any stimulation, while being measured for movement in the arms and legs. Movement was greatly reduced in the right limbs but not in the left limbs during exposure to speech. The implication was that more cortical

activity was occurring in the left-hemisphere which governs language. Along those same lines, Crowell and associates (1973) found that full-term newborns showed more right than left-hemisphere activation for rhythmic visual stimuli on bilateral EEG recording.

Caplan and Kinsbourne (1976) and Turkewitz, Moreau, Davis, and Birch (1969) have all reported that newborns turn their heads spontaneously to the right four times as often as to the left, and to be far more responsive to tactile, auditory, and visual stimuli presented at their right than at their left side, all of which seem to indicate an initial cerebral asymmetry.

Entus (1977) used a behavioral measure of cerebral specialization for language in infants, age 3 to 20 weeks, and found that the left-hemisphere responded more readily to speech stimuli (consonant-vowel syllables ba, da, ga, ma) measured by an increase in sucking, when the sound occurred in the right ear rather than in the left ear. The right-hemisphere responded more to music (sound A played on various instruments) evidence by an increase in sucking, when the sound occurred in the left ear rather than in the right ear.

Likewise, Davis and Wada (1977) found that 5-week-old babies showed more right-hemisphere activation for brief flashes of light. The left-hemisphere was activated for clicks which they argued called upon the fine temporal analysis of the left-hemisphere.

The evidence from these studies seems to indicate the possibility of innate lateral differences in hemispheric functioning. Consequently, Lenneberg's view that the two hemispheres are equal at birth is not supported by neuroanatomical studies of either newborns or infants.

Kimura (1967) used that dichotic listening technique to determine the age at which the left-hemisphere becomes lateralized for the perception of spoken words. She tested children in nursery school and elementary grades and was surprised to find that even 4-year-old children showed a significant verbal right ear superiority (left-hemisphere dominance).

What is clear from the research reviewed in this section is that hemispheric specialization is present at birth or before; however, there is still some question about the continued development of cerebral lateralization over time.

Sex Differences in Brain Development

Significant differences between right-handed males and females show up in the organization of the brain. During the past few years, researchers have found that females tend to be better than males in the use of oral language, while males tend to be better than females at spatial analysis (Hutt, 1972; Maccoby & Jacklin, 1974).

Further data from dichotic listening tests (Gordon, 1970; Kimura, 1961), tachistoscopic tests (Kimura, 1969; Kolb & Whishaw, 1980; Levy & Reid, 1976), whether stimuli are verbal or nonverbal, indicated that females are more bihemispheric (can use both hemispheres for language and spatial abilities) than males (Kolb & Whishaw, 1980).

Sex Differences Derived from Clinical Studies

Much of the data supporting sexual differences for verbal/visual asymmetry have come from clinical studies of adults and children. Lansdell (1962) was one of the first researchers to study the difference between male and female subjects regarding cerebral asymmetry. While working with epileptic patients at the National Institutes of Health, Lansdell hypothesized that there would be greater deficits in

visuo-spatial tasks following an operation on the right-hemisphere and greater deficit in verbal tasks following an operation on the left-hemisphere. His predictions were correct for males but not for females. The results lead Lansdell to conclude that females may have verbal/visual ability in both hemispheres, while males have language skills in the hemisphere opposite visuo-spatial skills.

According to Springer and Deutsch (1985), prior to Lansdell's (1962) study, investigations in brain research had not looked for nor found sex differences. They hypothesized that very few females had been studied since many of the patients were housed in U. S. Veterans Administration hospitals. Another possible explanation for the lack of reported sex differences is that most studies have utilized small samples. In order to detect sex related differences (Bryden, 1982) large samples are needed.

Sex Differences in Normal Children

Since Lansdell's study, many researchers have looked for and found notable differences between the sexes in normal subjects beginning at birth and continuing through adolescence.

Newborns and infants. Sex Differences in newborns and infants have been reported by McGuinness and Pribram (1978) and Watson (1969). Behavioral variability was observed in male and female newborns. Newborn females were more likely to respond to auditory stimuli which occurred in their environment, whereas males were biased toward visual stimulation (McGuinness & Pribram, 1978).

Infant stimulation studies have reported enhanced auditory reactive behavior by female infants over male infants (Watson, 1969). This increased responsiveness to sounds and voices appeared to exist at least through the school years.

Preschoolers to adolescents. Further evidence of sex differences in children related to cerebral asymmetry has been found by Bryden (1979); Rudel, Denckla, and Spalten (1974); and Witelson (1976). The dichaptic stimulation test was devised by Witelson (1974, 1976) for studying tactual perception in an effort to get more precise results of spatial functions when studying young children. Her dichaptic stimulation test can be used over a wide range of ages. The test require simultaneous presentation to each hand while objects were held out of view. After a specified amount of time, the subject would select the object from among a group of objects displayed visually. The data were then scored for the number of objects correctly selected by each hand. The results of Witelson's studies have provided evidence for sexual differences in the development of hemispheric specialization (visual-spatial processing). The right-hemisphere in males was more specialized than the left for processing spatial information, while females showed bilateral representation until age 13.

In regard to specific functions it has been reported that boys excel over girls on tasks of viso-spatial function by 4 years of age. Wilson's (1975) study confirmed this finding when he found male twins to be superior to their female co-twins on a maze test at ages 4-6. Porteus (1965) also found similar results when he studied male superiority on his maze test in children from nearly a hundred different cultures around the world.

Bryden (1970), Kimura (1967), Pizzamiglio and Cecchini (1971), and Van Duyne and D'Alonzo (1976), all found earlier and more pronounced left-hemisphere maturation in girls, as seen in greater

right-sided perceptual superiorities for verbal material. Girls were also found to verbalize more in response to their mother (Lewis, 1969; Lewis & Freedle, 1972). Language develops earlier in girls than in boys (Clarke-Stewart, 1973; Moore, 1967).

According to Durden-Smith and deSimone (1983), impulsivity and a physically aggressive style of childhood play were more commonly observed in males. Females engaged in a more passive and language oriented style of play. Boys were more likely to be drawn to objects and to their manipulation during play. Girls were predominantly drawn to the people in their environment and responded to faces rather than objects. When asked to draw, girls were likely to sketch human figures, whereas boys would draw things. Girls were more verbal in their play and later excelled in tasks that required verbal ability. Males were better in performing tasks which required visual-spatial ability and therefore were better in mental rotations, mazes, map reading, and mathematics.

The John Hopkins Study of Mathematically Precocious Youth (Benbow & Stanley, 1981, 1982, 1983) has reported significant differences between the sexes. The investigation focused on gifted seventh- and eighth-graders who had never taken courses in higher mathematics. The subjects were administered the mathematics subtest of the Scholastic Aptitude Test (SAT) in order to determine their natural ability in mathematics reasoning. Over 10,000 children were studied during a 6-year period. The results of the study showed that boys scored a much higher average than girls, and that no variable other than sex could explain the difference. Amount of instruction, fondness for mathematics, or degree of encouragement did not explain the difference.

Sex Differences Related to Maturational Factors

Waber (1976, 1979) has suggested that maturation is the source for many of the observed differences found in the verbal and visual-spatial ability of males and females. In a study of early and late maturers, the following relationships were predicted. First, early maturers would have more pronounced verbal than spatial abilities; late maturers would perform better on spatial tasks than on verbal ones. Second, early maturers would show less speech lateralization than late maturers.

The results indicated that children reaching puberty earlier than normal have brains that are less lateralized, that is, their left and right-hemispheres seem to share more tasks. Because girls normally reach puberty 2 years before boys, Waber's findings have caused some to speculate that the corpus callosum of the female brain has less time to lateralize (draw apart during puberty) than the male brain.

Sex Differences Related to Biological Factors

Geschwind and Behan (1982) studied sutjects who were strongly left-handed and displayed developmental learning disorders (e.g. dyslexia and stuttering) and certain immune diseases (e.g. thyroid or bowel disorders) than those who were strongly right-handed. They suggested that these disorders could be explained by the presence of high levels of the male hormone testosterone during fetal development.

Sex Differences Linked to Evolution

Levy (1978) theorized that the differences in lateralization between males and females are the result of evolution. Males have been the hunters and leaders of migrations since the beginning of human existence. Hunting requires good visuo-spatial skills which males were allowed to acquire giving them an advantage in developing the skill.

Females, on the other hand, have developed skills that are mainly associated with child rearing, such as the development of communication skills and the use of body language and other avenues of nonverbal communication. Levy has proposed that the use of both hemispheres by females has been necessary in the variety of tasks that have been associated with female duties. Males have required a more pronounced separation of the hemispheres in order to develop good visuo-spatial skills.

Studies with normal subjects have shown that males do appear to perform better than females on measures of spatial ability and mathematical aptitude (Affleck & Joyce, 1979; Stanley & Benbow, 1982; Fennema & Sherman, 1977; Restak, 1979). Spatial skills are attributed to processes normally associated with the right-hemisphere, while females, have been found to excel over males in the area of verbal skills which are attributed to processes normally associated with the left-hemisphere.

Summary of Research Implications

The research reviewed in this chapter on the organization of the brain, though still controversial, has considerable potential for helping educators better understand the brain function and development of learners. The evidence presented suggests that there are natural variations in children's learning, many of which can be identified by brain preference, age and sex stratification.

While most children are not totally left-brained or totally right-brained, there are children who have a dominant right-hemisphere with their language in the left-hemisphere and children who have a dominant left-hemisphere with language in the right-hemisphere. Some

children are extremely right-brained; some are extremely left-brained. Others vary in the degree of dominance of either hemisphere.

All of these variables indicate that there are children who show a facility in verbal and logical thought, but may lack physical coordination, have low visuo-spatial skills, and have difficulty generating images. Other children may show a talent for nonverbal and relational thought and expression, but may have delayed language development, or may have reading problems, but have excellent visuo-spatial skills.

As a result of the school's overemphasis on left-brain learning, many students have been identified as underachievers and slow learners. A great number of these children are having difficulty in school because they cannot switch from a right-hemisphere orientation to a left-hemisphere orientation or combine the two successfully. It appears that some students are right-hemisphere dominant and simply cannot make the switch.

Unfortunately, the right-hemisphere students, according to Schwartz (1980), are seldom allowed to display their skills in a meaningful way in most classrooms. Further, "verbal skills usually are rewarded regularly, while nonverbal skills are virtually ignored" (p. 100), thus, producing a high number of academic failures or near failures, who may other wise be highly intelligent students.

According to Grady and Luecke (1978-79) most school subjects depend mainly on reading. However, during reading lessons many teachers ask a high number of literal rather than non-literal questions, which focus mainly on the parts of text rather than the coherent whole (Pearson, 1985). Students who depend mainly on a global approach to reading and

comprehension, looking for patterns rather than the discrete parts, are at a disadvantage when asked to give answers to questions in workbooks.

If educators take note of learning principles and their relationship to cerebral organization, they will be in a better position to use to the best advantage their pupil's cognitive potential.

CHAPTER III

METHODS, PROCEDURES, AND INSTRUMENTATION

In this chapter, the problem and hypotheses are restated. The design of the study is included as well as the process for data collection and the methods employed in the data analysis. The chapter also provides a description of the sample, the Otis-Lennon School Ability Test, the Your Style of Learning and Thinking Inventory (Children's Form), and the Metropolitan Achievement Test.

Statement of the Problem and Hypotheses

The purpose of this study was to determine the relationships among hemispheric brain preferences, gender, and academic performance. Specifically two research questions were examined: (1) To what extent is academic performance affected by hemispheric brain preference as measured by a standardized test? and (2) To what extent are brain preferences affected by sex and/or grade level? Another major objective of this study was to assess the dominant hemisphere (left, right, and integrated) of students. Variations in performance on the Metropolitan Achievement Test were examined at the subtest level and at the basic-test level.

The following statistical hypotheses were tested at the .05 level of significance as specific components of the general research questions:

HO_1: There is no significant difference in hemispheric brain preference (left, right, and integrated) between fourth and seventh grade pupils.

HO_2: There is no significant difference in hemispheric brain preference (left, right, and integrated) between males and females.

HO_3: There are no significant differences in mean achievement among left-, right-, and integrated-hemisphere preference pupils in grade four and grade seven as measured by the Metropolitan Achievement Test (reading, mathematics, language, and basic score).

HO_4: There are no significant differences in mean achievement between the hemispheric brain preference categories and sex as measured by the Metropolitan Achievement Test (reading, mathematics, language, and basic score).

Study Design

The general research design utilized was a 2x3 analysis of variance. The dependent variables were the measures of achievement on the three subtests (and basic score) of the Metropolitan Achievement Test administered in April during the 1985-86 school year. The independent variables were sex and hemispheric brain preference for grade four and grade seven.

Students were assigned to either the right-hemisphere preference group, the left-hemisphere preference group, or the integrated-hemisphere preference group according to their performance on the children's form of the "Your Style of Learning and Thinking" Inventory. Thus, there was no randomization involved in the assignment of students to the particular brain preference groups. The results of the Otis-Lennon School Ability Test along with the Reading Instructional Level (RIL) from the Metropolitan Achievement Test were used to identify students of average or above-average ability.

Sample

The population for this study was 131 average and above-average ability white fourth and seventh grade students from three elementary schools and one middle school in the Alachua County Public School District. The students were divided into three groups according to their performance on a cerebral laterality measure. Each student had scores on all sections of the Metropolitan Achievement Test. Second grade scores for the fourth-graders and fifth grade scores for the seventh-graders were also collected on the Otis Lennon School Ability Test. However, a significant number of students did not have scores because of attendance in private schools or school districts not utilizing the OLSAT. Those students who did not have OLSAT scores were included in the final sample if they had Metropolitan Reading Instructional Level (RIL) scores equal to or above their present grade level.

The final sample consisted of 131 subjects. The students selected were all right-handed subjects (left-handers were eliminated), who met the established criteria for IQ range or instructional level, handedness, and MAT score availability. The fourth grade subjects had an age range of 8 years 11 months old to 11 years 1 month old, while the seventh grade subjects had an age range of 12 years 3 months old to 13 years 5 months old. There were 56 male subjects and 75 female subjects.

All students had Reading Instructional Levels on the Metropolitan Achievement Test equal to or higher than their grade level. Only one student had a subtest stanine in the 1 - 3 range and no student had an IQ less than 90. The mean IQ of the fourth grade subjects was 122, with a range of 94 - 148, while the mean IQ of the seventh grade subjects was 121, with a range of 102 - 143.

The final sample was limited to right-handed persons. The research literature on hemispheric specialization has reported consistent results for right-handed subjects and inconsistent unreliable results for left-handed subjects. Harris (1985) has stated that perhaps two-thirds of left-handers have linguistic functions represented on the left side of the brain, with the other one-third either having linguistic functions represented in the right-hemisphere or in both hemispheres. Handedness was assessed by having students indicate which hand was their writing hand. Another limiting factor was race; only white students were included in the study because of the small number of black students enrolled in the participating schools.

The distribution of subjects in the final sample is shown in Table 1 according to grade level, hemispheric brain preference, and sex. A complete profile of each student can be found in Appendix D.

Procedures

Permission to conduct this study was granted by the University of Florida Committee for the Protection of Human Subjects. In order to conduct the study in Alachua County, approval was obtained from the Director of Research at the Alachua County School Board and from the principals of the four public schools involved.

The principals at each participating school were asked for the use of a specific number of students. Consent forms (see Appendix A) were sent home with the students from their schools to be read, signed, and returned by their parents. The elementary school students were promised a small reward (stickers), which was provided by the investigator if the parental consent form was returned signed. Students were instructed to give the returned forms to their classroom teachers. The middle school students were not offered an incentive for returning the forms signed.

Table 1: Brain Preferences, Grade Level, and Sex of Subject Population

Brain Preference	Grade 4		Grade 7		
	Male	Female	Male	Female	Total
Left-Brain Preference	6	4	11	5	26
Right-Brain Preference	2	6	8	3	19
Integrated-Brain Preference	9	28	28	29	89
Total	17	38	39	37	131

A total of 157 students returned the signed consent forms, 64 from the elementary schools and 93 from the middle school.

One instrument, the Your Style of Learning and Thinking Inventory, Children's Form C-A, was administered in classes by the researcher. Prior to the administration of the test, students were told that they would be participating in a study that is designed to "find the ways that they and other students think and learn about things" and that "the information gained from the SOLAT would allow the investigator and other educators to find ways to help students do their best in school." Students were encouraged to participate in the study but were also given the option to decline. All other data were collected from existing records at the research department of the Alachua County School Board.

Instrumentation

The following instruments were utilized in this study:

1. The Metropolitan Achievement Test (MAT).
2. The Otis-Lennon School Ability Test (OLSAT).
3. Your Style of Learning and Thinking-Children's Form C-A (SOLAT).

Metropolitan Achievement Test (MAT)

The Metropolitan Achievement Test was standardized during the fall of 1977 and the spring of 1978. The sample (555,000) used for standardization is representative of the national population on the basis of geographic region, city size, socio-economic status, and public versus nonpublic schools (Prescott et al., 1978).

The survey battery provided stanines, raw scores, grade equivalents, percentile ranks, scale scores, and normal curve equivalent scores for each subtest. In addition, basic scores (reading + mathematics + language) and composite scores (reading + mathematics + language + social studies + science) were provided. Kuder-Richardson Formula 20

reliability estimates are presented in Table 2 for the Elementary and Advanced I levels, Form JS.

Otis-Lennon School Ability Test (OLSAT)

The Otis-Lennon School Ability Test is a revised version of the Otis Quick Scoring Mental Ability Test. According to the test manuals, students who were administered the MAT in the national population were also administered the OLSAT (Prescott et al., 1978). The test is divided into three major parts: classification, analogies, and a combination of items involving quantitative reasoning, verbal comprehension, and following directions. The scores on the OLSAT are converted into a "School Ability Index" (SAI) or IQ score (M=100, SD=16), which can be further converted into percentiles and/or stanines for each age and grade level.

Kuder-Richardson 20 reliability coefficients equal or exceed 0.90 for all age and grade levels. Alternate forms reliability coefficients for grade four range from r=0.81 to r=0.90. Grade five alternate forms correlations equal or exceed 0.90.

Your Style of Learning and Thinking (SOLAT)

Torrance and his associates (1976, 1977) developed the SOLAT, paper-pencil self-report instruments, which are used for assessing an individual's brain laterality preference. All forms of the SOLAT are of a multiple-choice format and have 40 items (except Form A which has 36 items) with three response options per item. The subject is confronted with three alternatives per item: one represents a right-hemisphere specialized function, the second represents a left-hemisphere specialized function, and the third represents an integrated way of functioning.

Norms and other technical data have been developed for four adult forms (A, B, C, MM) (Schwartz & Di Mattei, 1981; Torrance & Reynolds,

Table 2: Reliability Estimates for Subtests of the Metropolitan Achievement Test

	Elementary	Advanced I
Test	r_{K-R}	r_{K-R}
Reading	.96	.94
Mathematics	.90	.89
Language	.88	.90
Basic Battery	.97	.97

r_{K-R} (Kuder-Richardson Formula 20)

1980; Torrance, Reynolds, Riegal, & Ball, 1977) and three forms for children and adolescents (A, B, & C) (Reynolds, Kaltsounis, & Torrance, 1979). There is a logical rationale for each SOLAT item based on extensive research findings, and each item in the SOLAT instrument has withstood tests of internal consistency (Torrance, 1982).

The specific SOLAT instrument utilized in this study was the Children's Form of Your Style of Learning and Thinking (SOLAT), Form C-A, which consisted of 36 items. The instrument is basically untimed and can be administered in approximately 20 minutes. A handscoring key was used to determine the individual's highest hemisphere score, which was found by adding the number of items selected for each of the three option categories. The highest hemisphere score reflects the individual's cognitive mode (right, left or integrated).

The reading level of the Adult SOLAT was lowered significantly by the test's authors, without losing the meaning of the various concepts, in order to accommodate elementary and middle school subjects. According to the Fry Readability Formula (Fry, 1968), the Children's SOLAT has an estimated reading level of 4.0. Reliability coefficients for the SOLAT are reported in Table 3.

The following are two examples of SOLAT (Reynolds, Kaltsounis, & Torrance, 1979) items:

1. (a) In school, I like to read best of all. (scored left-hemisphere)
   (b) In school, I like to draw things. (scored right-hemisphere)
   (c) I like drawing and reading about the same. (scored integrated-hemisphere)
2. (a) I like to figure out all the steps in the answer to a problem. (scored left-hemisphere)

Table 3: Equivalent Forms Reliability Coefficients for the Your Style of Learning and Thinking Inventory (Children's Form)

Group	Right	Left	Integrated
Problem Solving Bowl Finalists			
Young Males	.86	.65	.87
Young Females	.97	.92	.58
Older Males	.57	.71	.82
Older Females	.82	.95	.54
Challenger Program Males	.56	.66	.74
Challenger Program Females	.73	.89	.66

(b) I like to write out everything about the answer to a problem. (scored right-hemisphere)

(c) I like answering problems either way. (scored integrated-hemisphere)

Data Collection

Data were collected by the investigator from scores on the children's form of the "Your Style of Learning and Thinking" Inventory (SOLAT), which identified pupils by hemispheric brain preference. The instrument was administered to all students in the four schools over a 5-day period in groups of 2 - 15 students. They were directed to write their names at the top of the answer sheet and to indicate their sex, race, and whether they were right- or left-handed. Although all students could read at the SOLAT reading grade level of 4.0, the test was read to the pupils while they read along with the investigator. The students completed the instrument during a portion of one class period in the investigator's presence.

Student achievement scores were also needed to determine the extent to which the development of laterality preferences are specifically related to the development of academic skills. The achievement measures collected included the stanines, raw scores, grade equivalents, percentile rank, and scaled scores on the subtests of the Metropolitan Achievement Test (reading, language, mathematics) and the basic score and the School Ability Index (SAI) from the Otis-Lennon School Ability Test.

Data Analysis

The two data analysis techniques utilized were ANOVA and chi square. The ANOVA is a statistical procedure used to test the effect of the independent variables on the dependent variables as well as the

interaction among and between variables. The General Linear Models subprogram of the Statistical Analysis System (SAS) computing package was employed in analyzing the data. The chi square analysis was used to answer hypotheses 1 and 2 which included the total sample. A 2x3 analysis of variance was used to test hypotheses 3 and 4. The level of significance for each hypothesis tested was set at .05. Separate analyses were run for the two grade levels included in the study. The dependent variables were each measure of achievement (reading, mathematics, language, and basic score) on the Metropolitan Achievement Test. The independent variables were brain preference and sex.

CHAPTER IV

ANALYSIS OF THE DATA

The purpose of the study was to determine the relationships among hemispheric brain preferences, gender, and academic performance. Specifically two research questions were examined: (1) To what extent is academic performance affected by hemispheric brain preference as measured by a standardized test? and (2) To what extent are brain preferences affected by sex and/or grade level?

The participants were 131 white fourth and seventh grade students identified by brain preference according to the "Your Style of Learning and Thinking" Inventory and grouped by sex and grade level. The dependent measures were the Metropolitan Achievement subtests (reading, mathematics, language) and the basic score. Using the Statistical Analysis System (SAS) computer program, the collected data were analyzed to test the four null hypotheses which provided specific direction for the investigation.

A chi square analysis was used to answer hypotheses 1 and 2. Analyses of variance (ANOVAS) were computed to answer hypotheses 3 and 4. Because of unequal observations per cell, the unweighted means solution to analysis of variance was used to analyze the data set.

The study results are organized into four sections, and the analysis for one of the research hypotheses is reported in each section. The complete analysis of variance results for each dependent variable by grade level are contained in Appendix B. Additional descriptive

statistics (means and standard deviations) obtained for the sample by group and subgroups are presented in Appendix C.

Hypothesis 1

Hypothesis 1 states that there is no significant difference in hemispheric brain preference (left, right, and integrated) between fourth and seventh grade pupils. In order to test this hypothesis a chi square statistic was applied. A χ^2 value of 0.171 was obtained with a significance level of 0.9182. This indicated that there was no significant difference found between grade level and brain preference. Thus, hypothesis 1 was confirmed. A cross-tabulation of brain preferences by grade level is reported in Table 4.

Table 4: Cross-Tabulation of Brain Preferences by Grade Level Reported in Percentages

	Grade Level		
	4	7	Total
Left-Preference	N=10 7.63%	N=16 12.21%	N=26 19.85%
Right-Preference	N=8 6.11%	N=11 8.40%	N=19 14.50%
Integrated-Preference	N=37 28.24%	N=49 37.40%	N=86 65.65%
Total	N=55 41.98%	N=76 58.02%	N=131 100.0%

Chi Square = 0.171
Significance = 0.9182
Degrees of Freedom 2

Hypothesis 2

Hypothesis 2 states that there is no significant difference in hemispheric brain preference (left, right, and integrated) between males and females. A chi square statistic was also applied to this hypothesis. A χ^2 value of 9.065 with a significance of 0.0108 was obtained. This indicated that there is a significantly higher number of females who have an integrated-brain preference. Thus, hypothesis 2 was rejected. A cross-tabulation of brain preferences by sex is reported in Table 5.

Table 5: Cross-Tabulation of Brain Preferences by Sex Reported in Percentages

	Sex		
	Male	Female	Total
Left-Preference	N=17 12.98%	N=9 6.87%	N=26 19.85%
Right-Preference	N=10 7.63%	N=9 6.87%	N=19 14.50%
Integrated-Preference	N=29 22.14%	N=57 43.51%	N=86 65.65%
Total	N=56 42.75%	N=75 57.25%	N=131 100.0%

Chi Square = 9.065
Significance = 0.0108
Degrees of Freedom 2

Hypothesis 3

Hypothesis 3 states that there are no significant differences in mean achievement among left-, right-, and integrated-hemisphere preference pupils for grade four and grade seven as measured by the Metropolitan Achievement Test (reading, mathematics, language, and basic score).

Analysis of Data--Reading

Grade four. The data for fourth grade reading scores for the three hemisphere preference groups were analyzed using the analysis of variance model, and the results are reported in Table 6. As shown in the table, the F ratio was 4.91 which was significant at the .05 level of confidence (0.0114).

The mean reading scores and standard deviations are displayed in Table 7. The reading achievement mean for the left-hemisphere group was 752.10, the right-hemisphere group was 723.62, and the integrated-hemisphere group was 773.64. The results of the Duncan range test for multiple comparisons applied to the means for hemispheric brain preference indicated that the integrated- and right-hemisphere groups differed significantly from each other. The integrated group achieved at a significantly higher level. Therefore, hypothesis 3 was rejected for grade four in reading.

Grade seven. Table 6 contains the results of the analysis of variance for seventh grade pupils in reading for the main effect of brain preference. As shown in the table, the F ratio was 0.61 which was not significant at the .05 level of confidence (0.5452).

The mean reading scores and standard deviations are shown in Table 8. The reading achievement means for the left-hemisphere group was 854.12, the right-hemisphere group was 879.45, and the

Table 6: Summary Results for the Main Effect of Brain Preference in Reading and Mathematics for Grade Four and Grade Seven

Tests	F Ratio	P > F
Reading		
Grade Four	4.91	0.0114*
Grade Seven	0.61	0.5452
Mathematics		
Grade Four	4.26	0.0197*
Grade Seven	0.67	0.5132

*p < .05

Table 7: Mean Score and Standard Deviation Data for the Metropolitan Reading Subtest by Hemispheric Brain Preference for Grade Four

Brain Preference	Number	Mean	S. D.
Left-Preference	10	752.10	45.64
Right-Preference	8	723.62	57.59
Integrated-Preference	37	773.64	43.22
Total	55	753.78	

Scaled Scores--MAT Elementary Level

Table 8: Mean Score and Standard Deviation Data for the Metropolitan Reading Subtest by Hemispheric Brain Preference for Grade Seven

Brain Preference	Number	Mean	S. D.
Left-Preference	16	854.12	67.99
Right-Preference	11	879.45	35.04
Integrated-Preference	49	876.42	46.82
Total	76	869.99	

Scaled Scores--MAT Advanced Level I

integrated-hemisphere group was 876.42. There was insufficient evidence to conclude that the mean scores for the three hemisphere groups were statistically different from one another. Hypothesis 3 was accepted for grade seven in reading.

Analysis of Data--Mathematics

Grade four. The results of the analysis of variance for the main effect of brain preference for grade four in mathematics are displayed in Table 6. As shown in the table, the F ratio was 4.26 which was significant at the .05 level of confidence (0.0197).

Table 9 contains the mean language scores and standard deviations. The left-hemisphere group had a mean of 715.10, the right-hemisphere group had a mean of 679.50, and the integrated-hemisphere group had a mean of 732.62. The results of the Duncan range test for multiple comparisons applied to the means for hemispheric brain preference revealed that the integrated- and right-hemisphere groups differed significantly from each other. The integrated-hemisphere group achieved at a higher level than the other two groups. Therefore, hypothesis 3 was not accepted for grade four in mathematics.

Grade seven. Table 6 contains the results of the analysis of variance for seventh grade pupils in mathematics for the main effect of brain preference. As shown in the table, the F ratio was 0.67 which was not significant at the .05 level of confidence (0.5132).

The mean mathematics scores and standard deviations are shown in Table 10. The left-hemisphere preference pupils' average mathematics score was 877.25, for the right-hemisphere preference students it was 865.09, and for the integrated-hemisphere preference students, the average score was 864.38. There was insufficient evidence to conclude that the mean scores for the three hemisphere groups were statistically

Table 9: Mean Score and Standard Deviation Data for the Metropolitan Mathematics Subtest by Hemispheric Brain Preference for Grade Four

Brain Preference	Number	Mean	S. D.
Left-Preference	10	715.10	56.49
Right-Preference	8	679.50	52.48
Integrated-Preference	37	732.62	60.67
Total	55	709.07	

Scaled Scores--MAT Elementary Level

Table 10: Mean Score and Standard Deviation Data for the Metropolitan Mathematics Subtest by Hemispheric Brain Preference for Grade Seven

Brain Preference	Number	Mean	S. D.
Left-Preference	16	877.25	80.14
Right-Preference	11	865.09	58.59
Integrated-Preference	49	864.38	69.03
Total	76	868.90	

Scaled Scores--MAT Advanced Level I

different from one another. Hypothesis 3 was accepted for grade seven in mathematics.

Analysis of Data--Language

Grade four. The data for fourth grade language scores for the three hemisphere preference groups were analyzed using the analysis of variance model, and the results are reported in Table 11. As shown in the table, the F ratio was 7.09 which was significant at the .05 level of confidence (0.0020).

The mean language scores and standard deviations are displayed in Table 12. The language achievement mean for the left-hemisphere preference group was 635.50. The language achievement mean for the right-hemisphere preference group was 698.12. The language achievement mean for the integrated-hemisphere preference group was 813.78. The results of the Duncan range test for multiple comparisons applied to the means for hemispheric brain preference indicated that the integrated- and right and integrated- and left-hemisphere preference groups differed significantly from each other. The integrated-hemisphere group achieved at a higher level than the other two groups. Therefore, hypothesis 3 was rejected for grade four in language.

Grade seven. Table 11 contains the results of the analysis of variance for seventh grade pupils in language for the main effect of brain preference. As shown in the table, the F ratio was 0.22 which was not significant at the .05 level of confidence (0.8046).

The mean language scores and standard deviations are shown in Table 13. The language achievement mean for the left-hemisphere preference group was 888.56, the right-hemisphere group was 894.81, and the integrated-hemisphere group was 905.46. No differences in mean achievement were found among left-hemisphere preference, right-hemisphere

Table 11: Summary Results for the Main Effect of Brain Preference in Language and Basic Score for Grade Four and Seven

Tests	F Ratio	P > F
Language		
Grade Four	7.09	0.0020*
Grade Seven	0.22	0.8046
Basic Score		
Grade Four	5.28	0.0084*
Grade Seven	0.19	0.8293

*p < .05

Table 12: Mean Score and Standard Deviation Data for the Metropolitan Language Subtest by Hemispheric Brain Preference for Grade Four

Brain Preference	Number	Mean	S. D.
Left-Preference	10	635.50	106.09
Right-Preference	8	698.12	90.39
Integrated-Preference	37	813.78	81.46
Total	55	749.46	

Scaled Scores--MAT Elementary Level

Table 13: Mean Score and Standard Deviation Data for the Metropolitan Language Subtest by Hemispheric Brain Preference for Grade Seven

Brain Preference	Number	Mean	S. D.
Left-Preference	16	888.56	79.99
Right-Preference	11	894.81	55.91
Integrated-Preference	49	905.46	61.61
Total	76	896.27	

Scaled Scores--MAT Advanced Level I

preference, and integrated-hemisphere preference pupils. Hypothesis 3 was accepted for grade seven in language.

Analysis of Data--Basic Score

Grade four. The results of the analysis of variance for the main effect of brain preference for grade four basic scores are displayed in Table 11. As shown in the table, the F ratio was 5.28 which was significant at the .05 level of confidence (0.0084).

Table 14 contains the mean basic scores and standard deviations. The mean for the left-hemisphere preference group was 732.40. The right-hemisphere preference group was 696.37 and the integrated-hemisphere preference group was 769.05. The results of the Duncan range test for multiple comparisons applied to the means for hemispheric brain preference indicated that integrated- and right-hemisphere preference groups differed significantly from each other. The integrated-hemisphere group achieved at a higher level than the other two groups. Therefore, hypothesis 3 was not accepted for grade four basic scores.

Grade seven. The data for seventh grade basic scores for the three hemisphere preference groups were analyzed using the analysis of variance model, and the results are reported in Table 11. As shown in the table, the F ratio was 0.19 which was not significant at the 0.5 level of confidence (0.8293).

The mean basic scores and standard deviations are displayed in Table 15. The mean for the left-hemisphere preference group was 877.18, the right-hemisphere preference group was 887.54, and the integrated-hemisphere preference group was 889.53. No difference in mean achievement was found among left-hemisphere preference, right-hemisphere preference, and integrated-hemisphere preference pupils. Hypothesis 3 was accepted for grade seven basic scores.

Table 14: Mean Score and Standard Deviation Data for the Metropolitan Basic Score (reading, mathematics, and language) by Hemispheric Brain Preference for Grade Four

Brain Preference	Number	Mean	S. D.
Left-Preference	10	732.40	69.44
Right-Preference	8	696.37	67.69
Integrated-Preference	37	769.05	61.27
Total	55	732.60	

Scaled Scores--MAT Elementary Level

Table 15: Mean Score and Standard Deviation Data for the Metropolitan Basic Score (reading, mathematics, and language) by Hemispheric Brain Preference for Grade Seven

Brain Preference	Number	Mean	S. D.
Left-Preference	16	877.18	82.51
Right-Preference	11	887.54	49.82
Integrated-Preference	49	889.53	60.37
Total	76	884.75	

Scaled Scores--MAT Advanced Level I

Hypothesis 4

Hypothesis 4 states that there are no significant differences in mean achievement between the hemispheric brain preference categories and sex as measured by the Metropolitan Achievement Test (reading, mathematics, language, and basic score).

Analysis of Data--Reading

Grade four. Table 16 contains the analysis of variance for fourth grade pupils resulting from the interaction of sex and hemispheric brain preference. As shown in the table, there were no sex differences nor was there a significant interaction between sex of pupils and hemispheric brain preference. The F ratio was 1.09 which was not significant at the .05 level of confidence (0.3441).

Means and standard deviations are shown in Table 17. The reading achievement means for the left-hemisphere group was 739.83 for males and 770.50 for females. The right-hemisphere preference group mean was 681.00 for males and 737.83 for females. The integrated-hemisphere preference group mean was 772.88 for males and 773.89 for females. The mean achievement in reading was similar for males and females in the three brain hemisphere categories, as indicated by the lack of a significant interaction between sex and brain preference. Hypothesis 4 was accepted for grade four in reading.

Grade seven. The grade seven reading data were analyzed by sex and brain preference using a two-way analysis of variance. The results of the analysis are reported in Table 18. As can be seen in the table, there were no sex differences nor was there a significant interaction between sex of pupils and hemispheric brain preference. The computed F ratio for the two-way interaction was equal to 1.07. The probability of obtaining a computed F value of this magnitude or greater if the null

Table 16: Analysis of Variance with Reading as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Four

Sources of Variation	*F* Ratio	*P* > *F*
Brain Preference	4.91	0.0114*
Sex	3.05	0.0868
Brain Preference x Sex	1.09	0.3441

*p < .05

Table 17: Mean Scaled Scores for MAT Reading Reported by Hemispheric Brain Preference and Sex for Grade Four

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	739.83	55.08	770.50	21.00
Right-Hemisphere	681.00	28.28	737.83	59.28
Integrated-Hemisphere	772.88	39.30	773.89	45.09

hypothesis was true was equal to .3492, which did not reach significance at the .05 level of confidence.

Table 19 contains the means and standard deviations for male and female pupils reported by hemispheric brain preference. The reading achievement mean for the left-hemisphere preference group was 843.54 for males and 877.40 for females. The right-hemisphere preference group mean was 882.12 for males and 872.33 for females. The integrated-hemisphere preference group mean was 883.00 for males and 871.89 for females. The mean achievement in reading was similar for males and females in the three brain hemisphere categories, as indicated by the lack of a significant interaction between sex and brain preference. Hypothesis 4 was accepted for grade seven in reading.

Analysis of Data--Mathematics

Grade four. The results of the analysis of variance for the interaction between brain preference and sex in mathematics are reported in Table 20. As shown in the table, there were no sex differences nor was there a significant interaction between sex of pupils and hemispheric brain preference. The F ratio for the two-way interaction was equal to 1.62. This was not significant beyond the .05 level of confidence (0.2087).

Table 21 contains the means and standard deviations for male and female pupils reported by hemispheric brain preference. The mathematics achievement mean for the left-hemisphere preference group was 715.33 for males and 714.75 for females. The right-hemisphere preference group mean was 616.00 for males and 700.66 for females. The integrated-hemisphere preference group mean was 740.33 for males and 730.14 for females. The mean achievement in mathematics was similar for males and females in the three brain hemisphere categories, as indicated by the

Table 18: Analysis of Variance with Reading as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Seven

Sources of Variation	F Ratio	P > F
Brain Preference	0.61	0.5452
Sex	0.08	0.7811
Brain Preference x Sex	1.07	0.3492

Table 19: Mean Scaled Scores for MAT Reading Reported by Hemispheric Brain Preference and Sex for Grade Seven

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	843.54	77.04	877.40	38.87
Right-Hemisphere	882.12	40.33	872.33	18.47
Integrated-Hemisphere	883.00	51.74	871.89	43.47

Table 20: Analysis of Variance with Mathematics as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Four

Sources of Variation	$\underline{F}$ Ratio	$\underline{P} > \underline{F}$
Brain Preference	4.26	0.0197*
Sex	1.29	0.2623
Brain Preference x Sex	1.62	0.2087

*p < .05

Table 21: Mean Scaled Scores for MAT Mathematics Reported by Hemispheric Brain Preference and Sex for Grade Four

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	715.33	73.59	714.75	23.41
Right-Hemisphere	616.00	11.31	700.66	40.98
Integrated-Hemisphere	640.33	61.40	630.14	61.36

lack of a significant interaction between sex and brain preference. Hypothesis 4 was accepted for grade four in mathematics.

Grade seven. The grade seven mathematics data were analyzed by sex and brain preference using a two-way analysis of variance. There were no significant sex or brain preference differences found. There was, however, a significant interaction between sex of pupils and hemispheric brain preference. The results of the interaction are reported in Table 22. The computed F ratio for the two-way interaction was equal to 3.71, which was significant beyond the .05 level of confidence (0.0294).

In order to explain the interaction, a Duncan range test for multiple comparisons was applied. The results revealed there was a significant difference between males and females in the integrated-hemisphere preference group with males having higher mean scores. No significant differences, however, were found between the other hemisphere preference groups and sex. Table 23 contains the means and standard deviations for male and female pupils reported by brain preference.

Analysis of Data--Language

Grade four. Table 24 contains the analysis of variance for language for fourth grade pupils resulting from the interaction of sex and hemispheric brain preference. As shown in the table, the F ratio for the interaction was 0.64 which was not significant at the .05 level of confidence (0.5295).

Means and standard deviations are shown in Table 25. The language achievement mean for the left-hemisphere group was 723.16 for males and 756.50 for females. The right-hemisphere preference group mean was 624.00 for males and 722.83 for females. The integrated-hemisphere preference group mean was 806.77 males and 816.03 females. There were no

Table 22: Analysis of Variance with Mathematics as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Seven

Sources of Variation	_F_ Ratio	_P_ > _F_
Brain Preference	0.67	0.5132
Sex	1.91	0.1709
Brain Preference x Sex	3.71	0.0294*

*p < .05

Table 23: Mean Scaled Scores for MAT Mathematics Reported by Hemispheric Brain Preference and Sex for Grade Seven

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	864.54	65.96	905.20	108.56
Right-Hemisphere	880.25	59.25	824.66	38.78
Integrated-Hemisphere	904.00	72.55	837.06	51.98

Table 24: Analysis of Variance with Language as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Four

Sources of Variation	F Ratio	P > F
Brain Preference	7.09	0.0020*
Sex	2.10	0.1538
Brain Preference x Sex	0.64	0.5295

*p < .05

Table 25: Mean Scaled Scores for MAT Language Reported by Hemispheric Brain Preference and Sex for Grade Four

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	723.16	135.74	756.50	46.57
Right-Hemisphere	624.00	16.97	722.83	91.93
Integrated-Hemisphere	806.77	58.76	816.03	88.34

sex differences nor did the interaction between sex and brain preference reach significance. Thus, hypothesis 4 was accepted for grade four in language.

Grade seven. The results of the analysis of variance for the interaction between brain preference and sex for language are reported in Table 26. As shown in the table, there were no sex differences nor was there a significant interaction between sex of pupils and hemispheric brain preference. The F ratio for the two-way interaction was equal to 1.33. This was not significant beyond the .05 level of confidence (0.2707).

Table 27 contains the means and standard deviations for male and female pupils reported by brain preference. The language achievement mean for the left-hemisphere preference group was 871.81 for males and 925.40 for females. The right-hemisphere preference group mean was 898.12 for males and 886.00 for females. The integrated-hemisphere preference group mean was 911.50 for males and 901.31 for females. There were no sex differences nor did the interaction between sex and brain preference reach significance. Therefore, hypothesis 4 was accepted for grade seven in language.

Analysis of Data--Basic Score

Grade four. The results of the analysis of variance for the interaction between brain preference and sex for the basic scores are reported in Table 28. As can be seen in the table, there were no sex differences nor was there a significant interaction between sex of pupils and hemispheric brain preference. The F ratio for the two-way interaction was equal to 0.83. This was not significant beyond the .05 level of confidence (0.4409).

Table 26: Analysis of Variance with Language as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Seven

Sources of Variation	*F* Ratio	*P* > *F*
Brain Preference	0.22	0.8046
Sex	0.28	0.6014
Brain Preference x Sex	1.33	0.2707

Table 27: Mean Scaled Scores for MAT Language Reported by Hemispheric Brain Preference and Sex for Grade Seven

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	871.81	75.04	925.40	86.32
Right-Hemisphere	898.12	58.85	886.00	57.88
Integrated-Hemisphere	911.50	66.82	901.31	58.59

Table 28: Analysis of Variance with Basic Score as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Four

Sources of Variation	F Ratio	P > F
Brain Preference	5.28	0.0084*
Sex	1.99	0.1642
Brain Preference x Sex	0.83	0.4409

*p < .05

Table 29: Mean Scaled Scores for MAT Basic Scores Reported by Hemispheric Brain Preference and Sex for Grade Four

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	725.33	90.30	743.00	25.00
Right-Hemisphere	637.50	24.74	716.00	66.66
Integrated-Hemisphere	766.00	56.63	770.03	63.65

Table 29 contains the means and standard deviations for male and female pupils reported by hemispheric brain preference. The basic score achievement mean for the left-hemisphere preference group was 725.33 for males and 743.00 for females. The right-hemisphere preference group mean was 637.50 for males and 716.00 for females. The integrated-hemisphere preference group mean was 766.00 for males and 770.03 for females. There were no sex differences nor did the interaction between sex and brain preference reach significance. Thus, hypothesis 4 was accepted for grade four basic scores.

Grade seven. The results of the analysis of variance for seventh grade pupils resulting from the interaction of sex and hemispheric brain preference is displayed in Table 30. There were no significant sex differences found. There was, however, a significant interaction between sex of pupils and hemispheric brain preference. The computed F ratio for the two-way interaction was equal to 3.35, which was significant beyond the .05 level of confidence (0.0409).

In order to explain the interaction, a Duncan range test for multiple comparisons was applied. The results revealed there was a significant difference between males and females in the integrated-hemisphere preference group with males having higher mean basic scores. No significant differences, however, were found between the other hemisphere preference groups and sex. Table 31 contains the means and standard deviations for male and female pupils reported by brain preference.

Summary

The results of the two data analysis techniques utilized were presented in this chapter. The chi square results revealed the following: (1) Fourth and seventh grade pupils showed no difference in

Table 30: Analysis of Variance with Basic Score as the Dependent Variable and Brain Preference and Sex as the Independent Variables for Grade Seven

Sources of Variation	F Ratio	P > F
Brain Preference	0.19	0.8293
Sex	0.04	0.8429
Brain Preference x Sex	3.35	0.0409*

*p < .05

Table 31: Mean Scaled Scores for MAT Basic Score Reported by Hemispheric Brain Preference and Sex for Grade Seven

	Sex			
	Male		Female	
Brain Preference	Mean	S. D.	Mean	S. D.
Left-Hemisphere	857.90	74.97	919.60	90.61
Right-Hemisphere	898.00	54.78	859.66	17.47
Integrated-Hemisphere	910.05	61.79	875.37	56.11

hemispheric brain preferences. (2) A significant difference was found in hemispheric brain preferences between males and females (more females had integrated-hemispheric preferences).

The analysis of variance results revealed the following: (1) Fourth grade integrated-hemisphere preference students had higher scores in reading, mathematics, language, and basic score than either the left- or right-hemisphere preference students. (2) Seventh grade students did not show a difference in hemispheric brain preference. (3) A sex by hemispheric brain preference interaction was found for seventh grade pupils in mathematics and basic score only (seventh grade integrated males achieved at higher levels than integrated females). (5) Fourth grade pupils did not show an interactive effect between hemispheric brain preferences and sex.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

In Chapter V the study is summarized, findings are reported, conclusions are discussed, and suggestions are given for further study.

Summary of the Problem

The problem of the study was to determine if there were differences in academic achievement of students according to their preferred style of learning and thinking and to determine if there were differences in academic achievement when the variable of sex was considered.

The students were 131 average and above-average ability white fourth and seventh grade students from three elementary and one middle school in the Alachua County School District. The total sample included 56 males and 75 females. All subjects included in the sample were right-handed and were divided into three groups according to their performance on a self-report cerebral laterality measure.

The primary data analysis techniques utilized were chi square analysis and analysis of variance. The chi square analysis was used to answer hypotheses 1 and 2 which included the total sample. A 2x3 analysis of variance was used to test hypotheses 3 and 4. The independent variables were brain preference and sex. Separate analyses were run for the two grade levels, fourth and seventh, included in the study. The dependent measures were the three subtests of the Metropolitan Achievement Test (reading, mathematics, and language) and the basic score.

Findings

Age-Related Differences

Hypothesis 1 stated that there would be no significant difference in hemispheric brain preference between fourth and seventh grade pupils. A cross-tabulation table of the brain preference levels by grade (see Table 4, Chapter 4) indicated a chi square value of 0.171 with a significance level of 0.9182. This was not significant at the .05 level of confidence. Thus, hypothesis 1 was accepted, which indicated that there were no differences in brain preference according to age.

Gender-Related Differences

Hypothesis 2 stated that there is no significant difference in hemispheric brain preference between males and females. A chi square test (see Table 5, Chapter 4) indicated a χ^2 value of 9.065 with a significance level of 0.0108. This was significant at the .05 level of confidence. Thus, hypothesis 2 was rejected, which indicated that a relationship did exist between brain preference and sex. More female students than male students were found to have integrated-hemispheric preferences.

Academic Achievement and Brain Preferences

Hypothesis 3 stated that there are no significant differences in mean achievement among left-, right-, and integrated-hemisphere preference pupils in grade four and grade seven as measured by the Metropolitan Achievement Test. This hypothesis was analyzed by a two-way analysis of variance (see Appendix B). The four ANOVA tables for grade four reading, mathematics, language, and basic scores did not support hypothesis 3. The integrated-hemisphere preference students achieved higher on all four tests given.

The seventh grade data for hypothesis 3 were also analyzed by a two-way analysis of variance (see Appendix B). The four ANOVA tables (reading, mathematics, language, and basic score) for grade seven supported the hypothesis of no differences in mean achievement among the three brain preference groups. There were no statistically significant differences in the achievement of any group. Thus, hypothesis 3 for seven grade students on all four measures was accepted.

Academic Achievement by Brain Preference and Sex

Hypothesis 4 stated that there are no significant differences in mean achievement between the hemispheric brain preference categories and sex as measured by the Metropolitan Achievement Test.

This hypothesis was analyzed by a two-way analysis of variance (see Appendix B). The four ANOVA tables for grade four supported the hypothesis of no differences in academic achievement among the three brain hemisphere preference groups according to sex. There were no statistically significant differences in achievement on any of the four test measures for the three groups according to sex. Males and females in each brain preference group achieved at about the same level. Therefore, hypothesis 4 for grade four was accepted.

The seventh grade data for hypothesis 4 were also analyzed using a two-way analysis of variance (see Appendix B). Two of the ANOVAs (reading and language) supported hypothesis 4 and two (mathematics and basic score) did not support the hypothesis of no differences in mean achievement among the three brain hemisphere preference groups according to sex.

Males and females in the three brain hemisphere preference groups had achievement means in reading and language that were not statistically significant from one another. Therefore, hypothesis 4 for grade seven in reading and language was accepted.

The ANOVA table for seventh grade mathematics according to sex and brain preference (see Appendix B) indicated a significant difference in the achievement level of males and females. Subsequently, a Duncan range test was run, which indicated that the difference in mean achievement between males and females was significant but only for the integrated-hemisphere preference group, with males scoring higher than females. Thus, hypothesis 4 for grade seven in mathematics was rejected.

The ANOVA table for seventh grade basic scores according to sex and brain preference (see Appendix B) also indicated a significant difference in the achievement level of males and females. Therefore, a Duncan range test was run, which indicated that the difference in mean achievement between males and females was significant but only for the integrated-hemisphere preference group, with males scoring higher than females. Thus, hypothesis 4 for grade seven basic score was also rejected.

Conclusions

The results of this study did not reveal any differences between elementary students and middle school students in terms of brain preference. However, when males were compared to females in the total group there was a difference. More females than males preferred the integrated-hemisphere style of learning and thinking. This finding was consistent with research results which reported that females have both language and spatial abilities represented more bilaterally than do their male counterparts. Males tend to have spatial processing in the right-hemisphere and verbal processing in the left-hemisphere. Females, on the other hand, tend to have visual and verbal skills in both hemispheres.

There are several hypotheses in the literature that could help explain the differences between males and females. Waber (1979) has suggested a maturational reason for the difference between males and females. She purports that females are less lateralized than males because they reach puberty earlier than males.

Levy (1978) has argued that evolution is the basis for the differences in brain preferences between the sexes. Males have been the hunters and fighters, thus, allowing them to develop good visuo-spatial skills through more extensive development of right-hemispheric functions. Females, on the other hand, have developed skills that require both left- and right-hemispheric preferences, thus, limiting them in the extent of their development of the right-brain function which is associated with skill in mathematics.

Fourth grade integrated-hemisphere preference students had higher scores in reading, mathematics, language, and basic scores than either the left- or right-hemisphere preference students. These results suggest that an integrated-brain preference is essential at the fourth grade level to attain higher academic achievement especially for elementary school pupils. Students at this level may well have learned to use, to their advantage, the specialized properties of both the right- and left-hemisphere in learning to process information. Since reading, language, and mathematics, are often associated with linguistic functioning they are sometimes presented by researchers and educators as left-hemisphere activities. However, the latest research has shown that these subjects depend a great deal on the functions that are associated with the right-brain.

The academic skills that are associated with the right-hemisphere are visualization, creativity, art expression, singing and music, shapes

and patterns, spatial relationships, color sensitivity, feelings and emotions, and mathematical computation. Left-hemisphere academic skills are reading, phonics, language, listening, following directions, auditory association, handwriting, talking and reciting, locating details and facts, and symbols (Vitale, 1982, p. 9).

Seventh grade students did not show a difference in hemispheric brain preference. The most logical explanation for the fact that there was no difference in favor of the integrated student at the seventh grade level would be the differences in the teaching methodology between the elementary schools and the middle school participating in this study. However, there are no data in this study that provide an explanation of this phenomenon.

It appears that the left-hemisphere students in this study did not achieve as highly as the integrated pupils who have learned to use both modes of thinking in the basic skill areas that require such tasks. The left-hemisphere learner does, however, achieve at a higher level than the right-hemisphere pupil who may be relying too heavily on right preference skills and may not have learned to use both modes of learning to maximum efficiency. This finding may be explained by the fact that the American public schools are channeling a great deal of learning in the classroom through the left-hemisphere mode which utilizes the analytical, sequential, and linear approaches to instruction. As stated by Bame and Gatewood (1983),

> Left-brain reading is the primary method of teaching and testing. The typical school's curriculum is heavily unbalanced toward the linear/sequential mode through emphasis upon the "basics." Standardized and intelligence tests are constructed primarily with a linear/sequential format geared to verbal rather than visual content. Very few opportunities exist for students labelled as slow learners in reading and mathematics by left-brain criteria to

> demonstrate their abilities in the right hemisphere. Most methods of recognizing gifted students neglect right-side or integrated hemisphere forms of genius. (p. 39)

The study also showed a sex by brain preference interaction for seventh grade pupils in mathematics and basic scores. The seventh grade integrated male pupils achieved at higher levels than did the female integrated-hemisphere preference students. The results seem to suggest that sex differences at the seventh grade level might be a result of the brain maturing at different rates for males and females. Girls generally tend to perform better than males in the elementary grades but do not perform mathematically as well as males in the upper grades. The research by Benbow and Stanley (1983), supported the above stated results. They found that there were significant differences between male and female mathematically gifted seventh-and eighth-graders who had never been given instruction in higher level mathematics. The only explanation they could find, after accounting for other possible variables, was the sex of the subjects.

Implications and Recommendations

The implications of this study suggest that it is desirable that educators become knowledgeable about the effects of various hemispheric preferences on academic performance. Further, a knowledge of the learning and thinking style preferred by students with regard to hemispheric preferences would enable educators to prepare lesson plans that include approaches to help students develop a more integrated style of learning if they have a dominate left- or right-preference.

The instrument used to assess brain preference in this study is still in the experimental stage, but will soon be on the market commercially. The use of this or similar instruments might prove useful

to educators because they would allow teachers to assess large numbers of students at a time.

The use of the SOLAT and the knowledge gained concerning the various modes of thinking would allow educators to plan programs which could enhance the skills of all learners in the classroom.

Recommendations for College Preparation Programs

Since teachers are responsible for the education of learners, then preservice teachers should receive information at the university level regarding brain preference and its many facets. More importantly, they should be made aware of the educational implications of hemispheric preferences of students. If teachers are to be so trained, then teacher educators must also become skillful in translating the theories and concepts of brain research into meaningful educational strategies that would help preservice teachers to provide appropriate instructional programs for children.

Recommendations for Researchers

Replication of this study with larger and more diverse samples is recommended if more generalizable conclusions about hemispheric brain preference are to be drawn. Ideally, the study described here should be initiated on a large scale, involving an entire school district comprised of a variety of ethnic and socioeconomic groups of children. The students to be included in the study would be representative of the average school-room situation with perhaps the usual range of low, average, and above-average children represented. The sample in the present study included average and above-average learners who did not represent a cross-section of socioeconomic levels, which would be a factor in the hypothesized study. Further, the group included in this study did not represent the cultural diversity of the average school system, but rather, was limited to one cultural group (white students).

Underachieving students in the elementary and middle schools could also be studied. The differences between the underachievers and achievers according to brain preference could be isolated. The importance of such a study would be the identification of the underachievers according to brain preference and the development of educational programs that are consistent with the students' individual strengths and needs. Thus, such programs might help these students learn to utilize a more integrated approach to processing information with the eventual outcome of raising their academic performance.

Recommendations for Educators

Inservice training. Teachers could be given inservice training in the use and interpretation of learning style instruments. They could also be made aware of recent trends and developments in education and in brain research related to learning style (cognitive style) and its implications for instruction and curriculum.

Teaching methods/learning style. In many classrooms, "teacher talk" takes up a great deal of the classroom instruction time. Students who do not prefer left-hemisphere functions, but rather, prefer right-hemispheric approaches to learning would benefit from a change in the instructors teaching style.

Instructional methods can help students learn to use both hemispheres if the instructors' modes of presentation would vary according to the learner's needs and the complexity of the material to be presented. Instructors in elementary and middle schools should allow more laboratory, hands-on type of activities. Laboratory activities could be planned that would provide students with opportunities for discovery learning, nonverbal (visual-motor and tactile) methods of expression, and problem-solving activities. The use of hands-on types

of activities would be especially useful in mathematics where students could have access to cuisenaire rods, puzzles, pentominoes, tangrams, soma cubes and other kinesthetic aids. The use of pictures, audio-visual material, and other media should also be encouraged.

Walker (1985) has listed three strategies that could help the right-brained learner achieve integrative brain processes which could lead to better reading comprehension. These strategies include (1) prediction maps that allow students to think visually, (2) story drama which calls for kinesthetic thinking, and (3) guided journeys which allow students to develop good imagery skills.

Hunter (1976) has suggested informal techniques that teachers can use to identify cerebral preferences. Children who like to draw picture stories or transform oral presentations into visual representations are probably right-brain processors and will probably need innovative teaching methods in order to learn to read.

All of the above stated activities can help students learn to use a variety of modes and methods that would encourage the development and use of an integrated style of learning. The students could also learn to shift from left-hemisphere processing to the right mode of processing as the activity demands. The most successful learners have been found to be more flexible in their information processing and problem-solving approaches to learning.

Evaluation. Teacher made tests could be designed to evaluate all three categories of learning styles. Perhaps this would mean finding ways to assess learners' knowledge other than the written approach.

Subject areas. Mathematics is thought to be a linear subject, but does involve a certain degree of visual thinking. In the elementary grades, computation that is emphasized should be presented in graphic

forms. In the upper grades, mathematics becomes more complex and, therefore, should be expressed in terms of visual logic as well as oral and written logic.

Ability grouping. If teachers use grouping in their classrooms, perhaps grouping in terms of a student's brain preference might be a realistic way to reach students with certain kinds of stimuli. Young children might benefit from a team-teaching approach, where a right-hemisphere preference teacher and a left-hemisphere preference teacher would be responsible for a particular set of learners. This kind of arrangement would provide a balanced approach of right- and left-preference materials and instructional strategies in classrooms where there are a mixture of brain preferences.

REFERENCES

Affleck, G., & Joyce, P. (1979). Sex differences in the association of cerebral hemispheric specialization of spatial function with conservation task performance. Journal of Genetic Psychology, 134, 271-280.

Akelaitis, A. J. (1941). Studies on the corpus callosum. II: The higher visual functions in each homonymous field following complete section of the corpus callosum. Archives of Neurology and Psychiatry, 45, 796-799.

Akelaitis, A. J. (1944). The study of gnosis, praxis and language following section of the corpus callosum and anterior commissure. Journal of Neurosurgery, 1, 94-102.

Bame, E. A., & Gatewood, T. E. (1983). Brain functioning: Implications for curriculum and instruction in industrial arts. Journal of Industrial Teacher Education, 20(2), 36-44.

Bakan, P. (1969). Hypnotizability, laterality of eye movement and functional brain asymmetry. Perceptual and Motor Skills, 23, 927-932.

Basser, L. S. (1962). Hemiplegia of early onset and the faculty of speech with special reference to the effects of hemispherectomy. Brain, 85, 427-260.

Benbow, C., & Stanley, J. (1981). Mathematical ability: Is sex a factor? Science, 212, 118-119.

Benbow, C., & Stanley, J. (1983). Sex differences in mathematical reasoning: More facts. Science, 222, 1029-1033.

Bogen, J. E. (1969). The other side of the brain II: An appositional mind. Bulletin of the Los Angeles Neurological Society, 34, 135-162.

Bogen, J. E. (1975). Educational aspects of hemispheric specialization. UCLA Educator, 17(2), 24-32.

Bogen, J. E. (1977). Some educational implications of hemispheric specialization. In M.C. Wittrock (Ed.), The human brain (pp. 133-152). Englewood Cliffs, NJ: Prentice-Hall.

Bogen, J. E., Sperry, R. W., and Vogel, P. J. (1969). Addendum: Commissural section and propagation of seizures. In H. H. Hasper, A. A. Ward, and A. Pope (Eds.), Basic mechanisms of the epilepsies. (pp. 439-440). Boston, MA: Little.

Bogen, J. E., & Vogel, P. J. (1962). Cerebral commissurotomy: A case report. Bulletin of the Los Angles Neurological Societies, 27, 169.

Bogen, J. E., & Vogel, P. J. (1963). Treatment of generalized seizures by cerebral commissurotomy. Surgical Forum, 14, 431.

Bradshaw, J. L., & Nettleton, N. C. (1981). The nature of hemispheric specialization in man. The Behavioral and Brain Sciences, 4, 51-91.

Broadbent, D. E. (1954). The role of auditory localization in attention and memory span. Journal of Experimental Psychology, 47, 191-196.

Brown, J. W., & Jaffe, J. (1975). Hypothesis on cerebral dominance. Neuropsychologia, 13, 107-110.

Bryden, M. P. (1970). Laterality effects in dichotic listening: Relations with handedness and reading ability in children. Neuropsychologia, 8, 433-450.

Bryden, M. P. (1979). Evidence for sex-related differences in cerebral organization. In M. Wittig & A. C. Petersen (Eds.), Sex-related differences in cognitive functioning: Developmental issues (pp. 121-143). New York: Academic Press.

Bryden, M. P. (1982). Laterality: Functional asymmetry in the intact brain. New York: Academic Press.

Butler, S. R., & Glass, A. (1974). Asymmetries in the electroencephalogram associated with cerebral dominance. Electroencephalography and Clinical Neurophysiology, 36, 481-491.

Caplan, P. J., & Kinsbourne, M. (1976). Baby drops the rattle: Asymmetry of duration of grasp by infants. Child Development, 47, 532-534.

Carlson, J., Netley, C., Hendrick, E. G., & Prichard, J. S. (1968). A reexamination of intellectual disabilities in hemispherectomized patients. Transactions of the American Neurological Association, 93, 198-201.

Clarke-Stewart, K. A. (1973). Interactions between mothers and their young children: Characteristics and consequences. Monographs of the Society for Research in Child Development, 38 (Serial No. 153).

Crowell, D. H., Jones, R. H., Kapuniai, L. E., & Nakagawa, J. K. (1973). Unilateral cortical activity in newborn humans: An early index of cerebral dominance? Science, 180, 205-208.

Day, M. E. (1964). An eye movement phenomenon relating to attention, thought, and anxiety. Perceptual and Motor Skills, 19, 443-446.

Durden-Smith, J., & deSimone, D. (1983). Sex and the brain. New York: Warner Books.

Ehrlichman, H. (1977). Field-dependence-independence and lateral eye movements following verbal and spatial questions. Perceptual and Motor Skills, 44, 1229-1230.

Ehrlichman, H., Weiner, S., & Baker, H. (1974). Effects of verbal and spatial questions on initial gaze shifts. Neuropsychologia, 12, 265-277.

Eisner, E. (1981). Mind as cultural achievement. Educational Leadership, 38, 466-471.

Entus, A. K. (1977). Hemispheric asymmetry in processing of dichotically presented speech and nonspeech stimuli by infants. In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological theory (pp. 63-73). New York: Academic Press.

Ettlinger, G., Warrington, E. K., & Zangwill, O. L. (1957). A further study of visual-spatial agnosia. Brain, 80, 335-361.

Fennema, E. & Sherman, J. (1977). Sex-related differences in mathematics achievement, spatial visualization and affective factors. American Educational Research Journal, 14, 51-71.

Fox, P. L. (1979). Reading as a whole brain function. The Reading Teacher, 33, 7-14.

Fry, E. P. (1968). Readability formula that saves time. Journal of Reading, 11, 513-516 & 575-577.

Galin, D., & Ellis, R. R. (1975). Asymmetry in evoked potentials as an index of lateralized cognitive processes: Relation to EEG alpha asymmetry. Neuropsychologia, 13, 45-50.

Galin, D., & Ornstein, R. (1972). Lateral specialization of cognitive mode: An EEG study. Psychophysiology 9, 412-418.

Gazzaniga, M. S. (1975). Review of the split-brain. UCLA Educator, 17(2), 9-12.

Gazzaniga, M. S., & Ledoux, J. E. (1978). The integrated mind. New York: Plenum.

Geschwind, N., & Behan, P. (1982). Left-handedness: Association with immune disease, migraine, and developmental learning disorder. Proceedings of the National Academy of Science, 79, 5097-5100.

Geschwind, N., & Levitsky, W. (1968). Human brain: Left-right asymmetries in temporal speech region. Science, 161, 186-187.

Gilinsky, A. S. (1984). Mind and brain: Principles of neuropsychology. New York: Praeger.

Gordon, H. (1970). Hemispheric asymmetries in the perception of musical chords. Cortex, 6, 387-398.

Grady, M. P. (1980). Teaching and brain research: Guidelines for the classroom. New York: Longman.

Grady, M. P., & Luecke, E. A. (1978). Education and the brain (Fastback 108). Bloomington, IN: Phi Delta Kappa Educational Foundation.

Gray, E. (1980). Brain hemispheres and thinking styles. The Clearing House, 54, 127-132.

Grow, M. F., & Johnson, N. (1983). Math learning: The two hemispheres. Humanistic Education and Development, 22(1), 30-39.

Gur, R. E., Gur, R. C., & Harris, L. J. (1975). Cerebral activation, as measured by subjects' lateral eye movements, is influenced by experimenter location. Neuropsychologia, 13, 35-44.

Harris, L. J. (1985). Teaching the right brain: Historical perspective on a contemporary educational fad. In C. T. Best (Ed.), Hemispheric function and collaboration in the child. (pp. 231-274). London: Academic Press.

Hines, D. (1975). Independent functioning of the two cerebral hemispheres for recognizing bilaterally presented tachistoscopic visual-half-field stimuli. Cortex, 11, 132-143.

Hunter, M. (1976). Right-brained kids in left-brained schools. Today's Education, 65, 45-48.

Hutt, C. (1972). Males and females. Baltimore, MD: Penguin.

Kimura, D. (1961). Cerebral dominance and the perception of verbal stimuli. Canadian Journal of Psychology, 15, 166-171.

Kimura, D. (1963). Right temporal lobe damage: Perception of unfamiliar stimuli after damage. Archives of Neurology, 8, 264-271.

Kimura, D. (1967). Functional asymmetry of the brain in dichotic listening. Cortex, 3, 163-178.

Kimura, D. (1969). Spatial localization in left and right visual fields. Canadian Journal of Psychology, 23, 445-448.

Kinsbourne, M. (1972). Eye and head turning indicates cerebral lateralization. Science, 176, 539-541.

Kolb, B., & Whishaw, I. (1980). Fundamentals of human neuropsychology. San Francisco, CA: Freeman.

Krashen, S. D. (1973). Lateralization, language learning, and the critical period: Some new evidence. Language Learning, 23, 63-74.

Lansdell, H. (1962). A sex difference in effect of temporal-lobe neurosurgery on design preference. Nature, 194, 852-854.

LeMay, J., & Culebras, A. (1972). Human brain-morphologic differences in the hemispheres demonstrable by carotid arteriography. New England Journal of Medicine, 287, 168-170.

Lenneberg, E. (1967). Biological foundations of language. New York: Wiley.

Levy, J. (1978). Lateral differences in the human brain in cognition and behavior control. In P. Buser & A. Rougeul-Buser (Eds.), Cerebral correlates of conscious experience (pp. 285-298). New York: North Holland Publishing Co.

Levy, J., & Reid, M. (1976). Variations in writing posture and cerebral organization. Science, 194, 337-339.

Levy-Agresti, J., & Sperry, R. W. (1968). Differential perceptual capacities in major and minor hemispheres. Proceedings of the National Academy of Science, U.S.A. 61, 1151.

Lewis, M. (1969). Infants' responses to facial stimuli during the first year of life. Developmental Psychology, 1, 75-86.

Lewis, M., & Freedle, R. (1972). Mother-infant dyad: The cradle of meaning. Symposium on language and thought: Communication and affect. Erindale College, University of Toronto, March.

Maccoby, E. E., & Jacklin, C. N. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

McCallum, R. S., & Glynn, S. M. (1979). Hemispheric specialization and creative behavior. Journal of Creative Behavior, 13, 263-273.

McFie, J. (1961). The effects of hemispherectomy on intellectual functioning in cases of linguistic hemiplegia. Journal of Neurology, 24, 240-249.

McGuinness, D., & Pribram, K. (1978). The origins of sensory bias in the development of gender differences in perception and cognition. In M. Bortner (Ed.), Cognitive growth and development: Essays in memory of Herbert G. Birth (pp. 3-56). New York: Brunner/Mazel.

Moore, T. (1967). Language and intelligence: A longitudinal study of the first eight years. Part 1. Patterns of development in boys and girls. Human Development, 10, 88-106.

Myers, R. E., & Sperry, R. W. (1953). Interocular transfer of visual form discrimination habit in cats after section of the optic chiasma and corpus callosum. Anatomical Records, 115, 351-352.

Nebes, R. D. (1977). Man's so-called minor hemisphere. In M. C. Wittrock (Ed.), The human brain (pp.97-106). Englewood Cliffs, NJ: Prentice-Hall.

Pearson, P. D. (1985). Changing the face of reading comprehension instruction. The Reading Teacher, 38(8), 724-738.

Pizzamiglio, L., & Cecchini, M. (1971). Development of the hemispheric dominance in children from 5 to 10 years of age and their relations with the development cognitive processes abstract. Brain Research, 31, 363-364.

Porteus, S. D. (1965). Porteus Maze Test. Fifty years' application. Palo Alto, CA: Pacific Books.

Prescott, G. A., Balow, I. H., Hogan, T. P., & Farr, R. C. (1978). Metropolitan Achievement Tests: Manual for administering and interpreting. New York: Harcourt Brace Jovanovich, Inc.

Restak, R. (1979). The other difference between boys and girls. Educational Leadership, 37, 234-235.

Reynolds, C. R., Kaltsounis, B., & Torrance, E. P. (1979). A children's form of your style of learning and thinking: Preliminary norms and technical data. Gifted Child Quarterly, 34(4), 757-767.

Rosenthal, R., & Jacobson, L. (1968). Pygmalion in the classroom: Teacher expectations and pupils' intellectual development. New York: Harper Row.

Rudel, R., Denckla, M., & Spalten, E. (1974). The functional asymmetry of braille letter learning in normal sighted children. Neurology, 24, 733-738.

Samples, R. (1977). Mind cycles and learning. Phi Delta Kappan, 58, 688-692.

Schwartz, G. E., Davidson, R. J., & Maer, F. (1975). Right hemisphere lateralization for emotion in the human brain: Interactions with cognition. Science, 180, 286-288.

Schwartz, H. A. (1980). Cerebral organization, handedness, and education. Academic Therapy, 16(1), 95-100.

Schwartz, S. A., & Di Mattei, R. (1981). Mobius Psi-Q Test. Omni, 4(1), 132-134; 136; 138; 159-160.

Segalowitz, S., & Chapman, J. (1980). Cerebral asymmetry for speech in neonates: A behavioral measure. Brain and Language, 9, 281-288.

Sinatra, R., & Stahl-Gemake, J. (1983). Using the right brain in the language arts. Springfield, IL: Charles C. Thomas.

Sperry, R. W. (1961). Cerebral organization and behavior. Science, 133, 1749-1757.

Sperry, R. W. (1974). Lateral specialization in the surgically separated hemispheres. In F. O. Schmitt & F. G. Worden (Eds.), The neurosciences third study programs (pp. 5-19). Cambridge, MA: MIT Press.

Sperry, R. W., Gazzaniga, M. S., & Bogen, J. E. (1969). Interhemispheric relationships: The neocotical commissures; Syndromes of hemispheric deconnection. In P. J. Vinkin, & G. W. Bruyn (Eds.), Handbook of clinical neurology Vol. 4 (pp. 273-290). Amsterdam: North Holland.

Springer, S., & Deutsch, G. (1985). Left brain, right brain. San Francisco, CA: W. W. Freeman.

Stanley, J., & Benbow, A., (1982). Huge sex ratios at upper end. American Psychologist, 37(8), 792.

Sylwester, R. (1981). Educational implications of recent brain research. Educational Leadership, 39(1), 7-10.

Sylwester, R. (1982). The human brain. Part II. A child's brain: How every single cell is organized for action. Instructor, 38, 64-67.

Thompson, R. F., Berger, T. W., & Berry, S. D. (1980). Brain anatomy and function. In M. C. Wittrock (Ed.). The brain and psychology, (pp. 1-32). Englewood Cliffs, NJ: Prentice-Hall.

Torrance, E. P. (1982). Hemisphericity and creative functioning. Journal of Research and Development in Education, 15, 29-37.

Torrance, E. P., & Reynolds, R. C. (1980). Preliminary norms technical manual for Your Style of Learning and Thinking, Form C. Athens, GA: Georgia Studies of Creative Behavior.

Torrance, E. P., Reynolds, C. R., & Kaltsounis (1977). A Children's Form of Your Style of Learning and Thinking: Preliminary Norms and Technical Data. The Gifted Child Quarterly, 23(4), 757-766.

Torrance, E. P., Reynolds, C. R., Riegel, T., & Ball, O. (1977). Your style of learning and thinking, forms A and B. Gifted Child Quarterly, 21, 563-573.

Torrance, E. P., Riegal, T., & Reynolds, C. R. (1976). Preliminary manual: Your style of learning and thinking. Athens: University of Georgia, Department of Educational Psychology.

Turkewitz, G., Moreau, T., Davis, L., & Birch, H. (1969). Factors affecting lateral differentiation in the human newborn. Journal of Experimental Child Psychology, 8, 483-493.

Van Duyne, J., & D'Alonzo, B. J. (1976). Amount of verbal information and ear differences in 5-and 6-year-old boys and girls. Perceptual and Motor Skills, 43, 31-39.

Van Wagenen, W., & Herren, R. (1940). Surgical division of commissural pathways in the corpus callosum. Archives of Neurology and Psychiatry, 44, 740-759.

Vitale, B. (1982). Unicorns are real: A right-brained approach to learning. Rolling Hills Estates, CA: Jalmar Press.

Waber, D. (1976). Sex differences in cognition: A function of maturation rate? Science, 192, 572-574.

Waber, D. (1979). Cognitive abilities and sex-related variations in the maturation of cerebral cortical functions. In M. Wittig & A. Petersen (Eds.), Sex-related differences in cognitive functioning (pp. 161-186). New York: Academic Press.

Wada, J. A., Clarke, R., & Hamm, A. (1975). Cerebral hemispheric asymmetry in humans. Cortical speech zones in 100 adults and 100 infant brains. Archives of Neurology, 32, 239-246.

Wada, J. A., & Davis, A. (1977). Fundamental nature of human infants' brain asymmetry. Canadian Journal of Neurological Sciences, 4, 203-207.

Walker, B. M. (1985). Right-brained strategies for teaching comprehension. Academic Therapy, 21(2), 133-141.

Watson, J. S. (1969). Operant conditioning of visual fixation in infants under visual and auditory reinforcement. Developmental Psychology, 1, 508-516.

Webb, G. (1982). Left/right brains: Teammates in learning. Exceptional Children, 49, 508-515.

White, H. H. (1961). Cerebral hemispherectomy in the treatment of infantile hemiplegia. Confinia Neurologica, 31, 1-50.

White, K. D., & Silver, A. B. (1975). Cerebral hemispheres serve as two channels for visual information processing. Bulletin of the Psychonomic Society, 6(1), 51-52.

Wilson, R. S. (1975). Twins: Patterns of cognitive development as measured on the Wechsler Preschool and Primary Scale of Intelligence. Developmental Psychology, 11, 126-134.

Witelson, S. F. (1974). Hemispheric specialization for linguistic and nonlinguistic tactual perception using a dictotomous stimulation technique. Coxtex, 10, 3-17.

Witelson, S. F. (1976). Sex and single hemisphere: Specialization of the right hemisphere for spatial processing. Science, 193(4250), 425-426.

Witelson, S. F. (1977). Early hemisphere specialization and interhemisphere plasticity: An empirical and theoretical review. In S. Segalowitz & F. Gruber (Eds.), Language development and neurological theory (pp. 213-287). New York: Academic.

Witelson, S. F., & Pallie, W. (1973). Left hemisphere specialization for language in the newborn: Neuroanatomical evidence of asymmetry. Brain, 96, 641-647.

Wittrock, M. C. (1977). The generative processes of memory. In Merl C. Wittrock (Ed.), The human brain (pp. 153-184). Englewood Cliffs, NJ: Prentice-Hall.

Wittrock, M. C. (1980). Learning and the brain. In M. C. Wittrock (Ed.), The brain and psychology (pp. 371-403). New York: Academic Press.

Zangwill, O. L. (1960). Cerebral dominance and its relation to psychological function. Edinburgh: Oliver & Boyd.

APPENDIX A

INFORMED CONSENT FORM
AND
STUDENT ASSENT SCRIPT

443 Little Hall
University of Florida
Gainesville, FL 32612

Informed Consent

Dear _____________________:

Your child has been selected to participate in a study that is designed to compare the different ways students use to think and learn about things. The students selected for this study are fourth and seventh graders attending schools in Alachua County. The following procedures will be employed in the study:

1. Students will be asked to answer written questions about their learning preferences on the "Your Style of Learning and Thinking" Inventory. This activity will take approximately 40 minutes to administer and will be completed during the school day. Each question will be read aloud so that all students will have approximately the same opportunity to complete the inventory.

2. Scores from the 1985-86 Metropolitan Achievement Test will also be recorded for each child from the Alachua County testing office.

3. The scores on both the Inventory and Metropolitan Achievement Test will be analyzed, interpreted and written up in a final report by the investigator.

There is no risk or discomfort involved in participating in the study and confidentiality will be strictly maintained during the investigation. At no time will any other person be able to associate your child's identity with the study results. The master list of names, inventory scores, and Metropolitan Achievement scores will be recorded by the investigator onto code sheets and fed into a computer, thereby, eliminating all possible ways of identifying your child. However, his/her teacher may find the group information gained from the study very helpful in planning various teaching strategies in the classroom.

Any questions that you may have concerning the study will be answered upon request. There will be no monetary compensation for participating in the study. Please understand that you or your child may withdraw your consent and terminate your participation at any time during the investigation.

Juanita C. Fountain, Graduate Student
Telephone 392-0788

I have read and I understand the procedures described above. I agree to allow my child, ______________________, to participate in the procedures and have received two copies of this description; one copy for me to keep and the other copy to be returned to the investigator.

(Parent)	(Date)	(Investigator)	(Date)
(2nd Parent)	(Date)	(Witness)	(Date)

Student Assent Script

You have been chosen for a study that will find the ways that you and other students think and learn about things. The information gained from the "Your Style of Learning and Thinking" survey will help me and other educators find ways to help students do their best in school. Eash item on the survey will be read aloud and you will be asked to answer each question as thoughtfully as possible.

If, for some reason, you do not wish to be in the study, you are allowed to return to your classes.

APPENDIX B

COMPLETE ANALYSIS
OF
VARIANCE RESULTS

Table 32: Analysis of Variance with Reading as the Dependent Variable and Sex and Brain Preference as the Independent Variables for Grade Four

Sources of Variation	Degrees of Freedom	Sums of Squares	Means Square	F value	$P > F$
Brain Preference	2	20456.25	10228.12	4.91	0.0114*
Sex	1	6367.43	6367.47	3.05	0.0868
Brain Preference x Sex	2	4545.91	2272.95	1.09	0.3441

*p < .05

Table 33: Analysis of Variance with Reading as the Dependent Variable and Sex and Brain Preference as the Independent Variables for Grade Seven

Sources of Variation	Degrees of Freedom	Sums of Squares	Means Square	F value	$P > F$
Brain Preference	2	3169.63	1584.81	0.61	0.5452
Sex	1	201.44	201.44	0.08	0.7811
Brain Preference x Sex	2	5532.34	2766.17	1.07	0.3492

Table 34: Analysis of Variance with Mathematics as the Dependent Variable and Sex and Brain Preference as the Independent Variable for Grade Four

Sources of Variation	Degrees of Freedom	Sums of Square	Means Square	_F_ value	_P_ > _F_
Brain Preference	2	29378.41	14689.20	4.26	0.0197*
Sex	1	4438.57	4438.57	1.29	0.2623
Brain Preference x Sex	2	11165.93	5582.96	1.62	0.2087

$^{*}p < .05$

Table 35: Analysis of Variance with Mathematics as the Dependent Variable and Sex and Brain Preference as the Independent Variable for Grade Seven

Sources of Variation	Degrees of Freedom	Sums of Square	Means Square	_F_ value	_P_ > _F_
Brain Preference	2	5656.18	2828.09	0.67	0.1709
Sex	1	8037.45	8037.45	1.91	0.5132
Brain Preference x Sex	2	31149.49	15574.74	3.71	0.0294*

$^{*}p < .05$

Table 36: Analysis of Variance with Language as the Dependent Variable and Sex and Brain Preference as the Independent Variables for Grade Four

Sources of Variation	Degrees of Freedom	Sums of Squares	Means Square	*F* value	*P* > *F*
Brain Preference	2	109850.18	54925.09	7.09	0.0020*
Sex	1	16258.81	16258.81	2.10	1.1538
Brain Preference x Sex	2	9979.80	4989.9	0.64	0.5295

$*p < .05$

Table 37: Analysis of Variance with Language as the Dependent Variable and Sex and Brain Preference as the Independent Variables for Grade Seven

Sources of Variation	Degrees of Freedom	Sums of Squares	Means Square	*F* value	*P* > *F*
Brain Preference	2	1857.71	928.85	0.22	0.8046
Sex	1	1172.61	1172.61	0.28	0.6014
Brain Preference x Sex	2	11339.92	5669.96	1.33	0.2707

$*p < .05$

Table 38: Analysis of Variance with Basic Score as the Dependent Variable and Sex and Brain Preference as the Independent Variables for Grade Four

Sources of Variation	Degrees of Freedom	Sums of Squares	Means Square	F value	P > F
Brain Preference	2	43207.99	21603.99	5.28	0.0084*
Sex	1	8161.96	8161.96	1.99	0.1642
Brain Preference x Sex	2	6816.27	3408.13	0.83	0.4409

*p < .05

Table 39: Analysis of Variance with Basic Score as the Dependent Variable and Sex and Brain Preference as the Independent Variables for Grade Seven

Sources of Variation	Degrees of Freedom	Sums of Squares	Means Square	F value	P > F
Brain Preference	2	1455.69	727.84	0.19	0.8293
Sex	1	153.51	153.51	0.04	0.8429
Brain Preference x Sex	2	25962.38	12981.19	3.35	0.0409*

*p < .05

APPENDIX C

MEANS AND STANDARD DEVIATIONS FOR METROPOLITAN ACHIEVEMENT TEST

Table 40: Means and Standard Deviations of the Fourth Grade Sample (n=55), Left-Brain (n=10), Right-Brain (n=8), and Integrated-Brain Preference Students (n=37) for the Metropolitan Achievement Test

	Grade Four Sample		Left-Preference		Right-Preference		Integrated-Preference	
	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Reading	753.78	48.81	752.10	45.64	723.62	57.59	773.64	43.22
Mathematics	709.97	56.54	715.10	56.49	679.50	52.48	732.62	60.67
Language	749.46	92.64	635.50	106.09	698.12	90.39	813.78	81.46
Basic Score	732.60	66.13	732.40	69.44	696.37	67.69	679.05	61.27

Table 41: Means and Standard Deviations of the Seventh Grade Sample (n=76), Left-Brain (n=16), Right-Brain (n=11), and Integrated-Brain Preference Students (n=49) for the Metropolitan Achievement Test

	Grade Seven Sample		Left-Preference		Right-Preference		Integrated-Preference	
	Mean	S. D.	Mean	S. D.	Mean	S. D.	Mean	S. D.
Reading	869.99	49.95	854.12	67.99	879.46	35.04	876.42	46.82
Mathematics	868.90	69.25	877.25	80.14	865.09	58.59	864.38	69.03
Language	896.27	65.83	888.56	79.99	894.81	55.91	905.46	61.61
Basic Score	884.75	64.23	877.18	82.51	887.54	49.82	889.53	60.37

APPENDIX D

METROPOLITAN RESULTS
FOR
EACH STUDENT

Table 42: Metropolitan Achievement Test Data in Reading and Mathematics for Each Student in Grade Four

	Reading Subtest			Mathematics Subtest		
Student Number	Stanine	Percentile Rank	Scaled Scores	Stanine	Percentile Rank	Scaled Scores
1	4	38	668	5	56	633
2	7	88	778	8	92	727
3	7	88	778	9	96	648
4	7	88	778	7	86	709
5	5	50	695	6	76	679
6	6	76	747	6	82	693
7	8	94	802	7	82	693
8	5	50	695	6	70	666
9	5	54	701	5	52	624
10	6	76	747	7	86	709
11	8	94	802	9	99	896
12	7	88	778	9	96	748
13	7	82	760	9	96	748
14	4	30	654	6	66	654
15	6	76	747	6	62	643
16	9	99	840	9	99	844
17	6	66	725	6	76	679
18	9	99	840	9	99	802
19	9	99	840	8	96	748
20	5	48	790	6	70	666
21	6	66	725	7	82	793
22	7	88	778	9	96	748
23	8	94	802	9	86	709
24	4	34	661	5	66	654

Table 42 -- continued

Student Number	Reading Subtest Stanine	Reading Subtest Percentile Rank	Reading Subtest Scaled Scores	Mathematics Subtest Stanine	Mathematics Subtest Percentile Rank	Mathematics Subtest Scaled Scores
25	8	94	802	9	96	748
26	5	44	680	6	70	666
27	7	82	760	9	99	802
28	6	76	747	6	70	666
29	7	82	760	7	82	693
30	7	88	778	9	98	772
31	8	94	802	9	98	772
32	8	94	802	9	99	844
33	8	94	802	7	86	709
34	6	76	747	9	96	748
35	7	82	760	6	62	643
36	4	34	661	5	44	608
37	6	76	747	7	82	693
38	8	94	802	7	86	709
39	7	88	778	9	98	772
40	9	99	840	9	98	772
41	6	76	747	9	98	772
42	8	94	802	9	99	748
43	8	94	802	7	86	709
44	7	82	760	7	86	709
45	7	88	778	6	76	679
46	9	99	840	8	92	727
47	5	58	708	6	76	679
48	7	82	760	7	86	709
49	6	70	735	6	76	679

Table 42 -- continued

Student Number	Reading Subtest Stanine	Reading Subtest Percentile Rank	Reading Subtest Scaled Scores	Mathematics Subtest Stanine	Mathematics Subtest Percentile Rank	Mathematics Subtest Scaled Scores
50	7	88	778	9	96	748
51	8	94	802	9	96	648
52	7	82	760	7	82	693
53	8	94	802	9	98	772
54	8	94	802	9	99	844
55	7	82	760	9	96	748

Table 43: Metropolitan Achievement Test Data in Language and Basic Score for Each Student in Grade Four

Student Number	Language Subtest Stanine	Language Subtest Percentile Rank	Language Subtest Scaled Scores	Basic Subtest Stanine	Basic Subtest Percentile Rank	Basic Subtest Scaled Scores
1	3	18	524	4	36	612
2	9	96	812	9	96	772
3	9	98	832	9	98	689
4	8	90	775	8	92	750
5	6	66	685	7	77	677
6	7	86	758	7	88	727
7	9	96	812	9	96	764
8	8	94	793	6	76	698
9	5	50	636	5	56	655
10	9	98	832	8	94	757
11	9	99	998	9	99	936
12	9	98	832	9	98	789
13	7	86	758	8	92	750
14	7	82	742	5	56	655
15	6	62	672	6	70	683
16	9	98	832	9	99	846
17	6	62	672	6	70	686
18	9	98	832	9	99	833
19	9	20	775	9	96	780
20	6	70	698	6	64	674
21	9	96	812	7	88	732
22	9	99	880	9	99	810
23	7	96	812	9	96	772
24	6	58	660	5	50	644
25	9	96	812	9	98	789

Table 43 -- continued

Student Number	Language Subtest Stanine	Language Subtest Percentile Rank	Language Subtest Scaled Scores	Basic Subtest Stanine	Basic Subtest Percentile Rank	Basic Subtest Scaled Scores
26	5	50	636	5	56	655
27	9	98	832	9	98	799
28	7	78	727	7	80	707
29	6	62	672	7	78	702
30	9	99	854	9	99	810
31	8	94	793	9	98	789
32	9	99	955	9	99	894
33	9	99	880	9	98	799
34	7	78	727	7	88	732
35	9	98	832	7	88	732
36	5	42	612	4	38	620
37	9	99	854	8	94	757
38	7	78	727	8	90	738
39	9	99	854	9	99	810
40	6	70	698	8	92	650
41	8	94	793	9	96	770
42	9	96	854	9	99	810
43	9	96	812	9	96	772
44	9	99	998	9	99	810
45	9	99	854	9	96	764
46	8	90	775	9	96	772
47	6	70	698	6	70	686
48	7	86	758	8	90	738
49	5	54	648	6	70	683
50	9	96	812	9	96	780

Table 43 -- continued

Student Number	Language Subtest			Basic Subtest		
	Stanine	Percentile Rank	Scaled Scores	Stanine	Percentile Rank	Scaled Scores
51	6	74	612	8	92	744
52	6	70	698	7	82	712
53	9	99	955	9	99	860
54	9	99	914	9	99	876
55	9	99	880	9	98	799

Table 44: Metropolitan Achievement Test Data in Reading and Mathematics for Each Student in Grade Seven

Student Number	Reading Subtest			Mathematics Subtest		
	Stanine	Percentile Rank	Scaled Scores	Stanine	Percentile Rank	Scaled Scores
1	8	94	883	9	98	918
2	8	94	883	7	77	797
3	8	89	851	9	98	918
4	9	98	902	8	92	869
5	9	99	924	8	94	884
6	8	89	851	7	77	797
7	7	83	837	8	89	842
8	9	99	924	9	98	918
9	9	99	951	7	77	797
10	9	99	951	7	82	808
11	8	94	883	9	99	957
12	8	94	883	7	82	808
13	9	99	986	9	99	996
14	8	94	883	9	92	869
15	9	99	951	7	82	808
16	8	94	883	9	99	957
17	7	80	818	6	70	778
18	7	80	818	8	89	842
19	6	60	771	8	76	869
20	8	92	866	9	96	900
21	8	92	866	7	86	830
22	8	94	883	8	92	869
23	9	99	925	9	99	999
24	8	92	866	8	89	842
25	8	94	883	8	94	884

Table 44 -- continued

Student Number	Reading Subtest Stanine	Reading Subtest Percentile Rank	Reading Subtest Scaled Scores	Mathematics Subtest Stanine	Mathematics Subtest Percentile Rank	Mathematics Subtest Scaled Scores
26	9	99	924	9	99	996
27	9	98	902	8	92	869
28	8	94	883	8	92	855
29	9	98	902	6	70	778
30	8	92	866	9	98	918
31	8	92	866	7	77	797
32	9	99	951	9	99	957
33	6	76	810	8	92	869
34	8	94	883	9	99	957
35	9	99	924	9	99	996
36	9	98	902	7	84	819
37	8	89	851	7	86	830
38	7	80	818	7	86	830
39	9	98	902	8	94	884
40	8	89	851	8	92	869
41	9	99	924	7	86	830
42	9	99	951	9	98	937
43	9	99	924	9	98	918
44	8	94	883	9	99	957
45	8	92	866	6	66	769
46	9	98	902	9	94	884
47	9	98	902	9	98	918
48	9	99	924	9	98	918
49	8	94	883	6	66	769
50	5	56	766	6	70	778

Table 44 -- continued

Student Number	Reading Subtest Stanine	Reading Subtest Percentile Rank	Reading Subtest Scaled Scores	Mathematics Subtest Stanine	Mathematics Subtest Percentile Rank	Mathematics Subtest Scaled Scores
51	7	82	827	5	40	718
52	8	89	851	8	94	884
53	6	74	802	8	92	855
54	8	92	866	7	86	830
55	8	94	883	8	94	884
56	8	89	851	9	99	996
57	8	92	866	7	86	830
58	6	68	788	6	70	778
59	9	98	902	9	98	937
60	9	99	951	9	96	900
61	7	80	818	9	98	918
62	8	92	866	7	84	819
63	6	70	795	8	92	855
64	5	54	761	5	56	746
65	8	94	883	9	98	937
66	6	76	810	8	94	884
67	6	60	771	8	92	855
68	7	80	818	9	98	937
69	7	82	827	6	74	787
70	8	92	866	6	60	753
71	9	99	951	7	86	830
72	8	94	883	9	99	980
73	7	86	838	8	92	869
74	9	99	924	9	98	937
75	6	68	788	6	64	761
76	7	82	827	6	66	769

Table 45: Metropolitan Achievement Test Data in Language and Basic Score for Each Student in Grade Seven

Student Number	Language Subtest			Basic Subtest		
	Stanine	Percentile Rank	Scaled Scores	Stanine	Percentile Rank	Scaled Scores
1	9	99	994	9	99	972
2	8	89	867	8	89	845
3	8	92	882	9	96	894
4	8	92	882	9	96	894
5	7	86	853	9	96	894
6	8	92	882	7	88	840
7	9	96	933	8	92	866
8	7	80	828	9	96	894
9	9	96	915	8	94	879
10	9	99	966	9	98	910
11	9	99	994	9	99	980
12	9	98	951	9	94	879
13	9	99	986	9	99	992
14	9	98	951	9	98	918
15	9	99	966	9	98	910
16	8	94	898	9	99	934
17	8	94	898	7	84	821
18	7	86	853	7	88	835
19	6	92	816	7	78	801
20	8	94	898	9	98	902
21	6	76	816	7	88	835
22	9	96	915	9	98	902
23	9	99	994	9	99	994
24	8	89	867	8	92	860
25	9	98	951	9	99	926

Table 45 -- continued

Student Number	Language Subtest Stanine	Language Subtest Percentile Rank	Language Subtest Scaled Scores	Basic Subtest Stanine	Basic Subtest Percentile Rank	Basic Subtest Scaled Scores
26	9	99	991	9	99	990
27	9	96	933	9	98	918
28	9	96	933	9	98	902
29	7	80	828	7	86	825
30	9	99	966	9	99	942
31	6	62	774	7	80	805
32	9	99	986	9	99	984
33	7	80	828	7	86	830
34	9	99	966	9	99	962
35	9	99	986	9	99	987
36	7	84	840	8	90	850
37	8	92	882	8	92	855
38	8	92	882	7	88	840
39	8	94	898	9	98	910
40	7	84	840	8	92	855
41	9	99	966	9	98	918
42	9	96	915	9	99	956
43	8	89	867	9	98	918
44	9	96	933	9	99	949
45	8	92	882	7	86	830
46	9	99	986	9	99	956
47	9	99	986	9	99	967
48	8	92	882	9	99	926
49	6	66	784	7	78	801
50	6	66	784	6	65	767

Table 45 -- continued

Student Number	Language Subtest			Basic Subtest		
	Stanine	Percentile Rank	Scaled Scores	Stanine	Percentile Rank	Scaled Scores
51	6	70	794	6	66	772
52	9	96	915	9	96	894
53	9	96	915	8	90	850
54	7	80	828	7	88	840
55	9	98	951	9	99	926
56	9	99	994	9	99	980
57	9	96	915	8	94	872
58	6	74	805	6	72	783
59	9	99	966	9	99	962
60	9	98	951	9	99	956
61	8	94	898	8	94	879
62	9	96	915	8	92	866
63	7	86	853	7	86	825
64	5	54	747	5	56	743
65	9	98	951	9	99	949
66	7	84	840	8	88	840
67	9	96	933	7	86	830
68	9	96	915	9	96	894
69	6	74	805	7	78	801
70	6	74	805	7	77	798
71	7	80	828	8	92	860
72	9	98	951	9	99	962
73	9	98	951	9	96	894
74	9	99	994	9	99	984
75	8	89	867	6	74	792
76	8	89	867	7	82	813

BIOGRAPHICAL SKETCH

Juanita Cummings Fountain was born in Gainesville, Florida, July 24, 1950. She attended the public schools of Alachua County, graduating from Lincoln High School in 1968.

In 1972 she received the Bachelor of Science degree, magna cum laude, in psychology from Bethune-Cookman College. She was elected to Who's Who Among Students in American Colleges and Universities, Alpha Kappa Mu (a scholastic honor society), and the Alpha Kappa Alpha Sorority. She was awarded the Master of Education degree in elementary education with a specialization in early childhood in 1974 from the University of Florida.

Between 1974 and 1978, she taught elementary school pupils in the Duval County Public School System, Jacksonville, Florida. From 1978 to the present, she has held a variety of teaching positions in the Gainesville area: Teaching Assistant--Reading Center, University of Florida; English Tutor--Program for Academic Counseling and Tutoring, University of Florida; Athletic Tutor, University of Florida; Reading Instructor, Upward Bound; Reading Instructor, Santa Fe Community College; and Elementary Education Instructor, Bethune-Cookman College.

She is a member of several honorary societies and professional organizations including Kappa Delta Pi, Pi Lambda Theta, Phi Kappa Phi, Beta Eta Sigma, and the Association for Supervision and Curriculum Development.

Juanita has been married to her husband, Charles, for 12 years, and is the mother of a 4-year old, Ivan Omar.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

H. T. Fillmer

Henry T. Fillmer, Chairman
Professor, Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Simon O. Johnson

Simon O. Johnson
Associate Professor, Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Elois M. Scott

Elois M. Scott
Associate Professor, Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Joseph Shea

Joseph J. Shea
Associate Professor, Instruction and Curriculum

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Edward C. Turner

Edward C. Turner
Associate Professor, Instruction and Curriculum

This dissertation was submitted to the Graduate Faculty of the College of Education and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December 1986

David C. Smith

Dean, College of Education

Dean, Graduate School